ISSUES IN GROUND WATER MANAGEMENT

AN EVALUATION OF MONTANA'S GROUND WATER POLICIES AND PROGRAMS

The Governor's Ground Water Advisory Council

January 1985

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ACKNOWLEDGMENTS

This report was prepared by the Water Management Bureau of the Department of Natural Resources and Conservation under the direction of the Governor's Ground Water Advisory Council. The report was assembled by Rich Brasch and edited by Peggy Todd and Sharleen Pendergrass. The text was typed by Julie Frickel and the cover and illustrations drawn by Barbara Lien.

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INTRODUCTION

As people demand larger and larger quantities of fresh, potable water, the use of ground water will become vitally important to the individual, to municipalities, and to industry. Ground water resources, which today constitute more than 95 percent of the world's total fresh water supply, are essentially uncontaminated in contrast to many surface water sources. Yet only about 20 percent of the water used in the United States--and an estimated 2 percent of the volume used in Montana--come from underground (Solley, et al, 1983). Because ground water is an abundant, relatively inexpensive, generally drought-proof source of fresh water, it is likely that more use will be made of it in the future.

The responsibility for development, management, and protection of the ground water resource is an important public trust. Ground water is part of an unseen system that is difficult to study directly and therefore difficult for the public to understand. Prudent development of ground water is important so that the public receives the full social and economic benefit of this essentially renewable resource. Even more important is the responsibility for protection of ground water from pollution which could prevent its use and--in severe cases--prove deleterious to human health.

What is the right path to wise development and protection of the ground water resource? Montana is facing this problem as more pressure is put on the underground system to serve both as a water supply source for homes, agriculture, and industry, and as a waste disposal medium.

Many other western states have placed severe demands on their ground water resources. These demands have resulted in conflicts requiring drastic remedial action to resolve. The primary difference between Montana and other western states is that ground water problems of depletion and contamination are not yet widely manifest in this state. Thus, Montanans have not yet been forced to impose widespread restrictions and expensive corrective measures on ground water use in reaction to those problems. Action now can give Montana the luxury of resolving similar problems early before management options are cut off.

In April 1982, the Environmental Quality Council, working with the Water Resources Oversight Committee and the Montana Water Resources Research Center, held the Montana Ground Water Conference in Great Falls. The conference acquainted legislators, water user groups, and the general public with some of the unique characteristics of ground water, identified problems associated with its use, and explained some of the requirements for ground water management and protection. The conference was an important step in formulating a ground water strategy for Montana.

As a result of this conference, the <u>Montana Ground Water Status Report</u> was prepared by ground water professionals from state and federal agencies and the state university systems. This report identified ground water issues facing Montana and presented options for their resolution. This report was of critical importance in guiding work on ground water issues over the subsequent two years. Copies of the draft report are available from the Montana Department of Natural Resources and Conservation.

After receiving suggestions from its participants, the Environmental Quality Council passed a motion in August 1982 requesting that the governor appoint an advisory council on ground water issues. A sixteen-member Ground Water Advisory Council was created by Governor's Executive Order to review Montana's present ground water management framework and develop recommendations for the governor, legislature, and state agencies on legislation or rule-making that would promote the wise development and protection of the state's ground water resources.

The Ground Water Advisory Council members are:

Representative Gay Holliday, Chairperson
Gary Fritz, Montana Department of Natural Resources and Conservation, Vice-chairperson
Representative Dennis Iverson
Senator Dorothy Eck
Senator Jack Galt
Dennis Nathe, Rancher
John Scully, Attorney
William Osborne, Water Well Drilling Contractor
John Duncan, Rancher
Dr. Stephan Custer, Montana State University
Dr. William Woessner, University of Montana
Marvin Miller, Montana Bureau of Mines and Geology
Joe Moreland, U.S. Geological Survey
Dennis Hemmer, Montana Department of State Lands
Fred Shewman, Montana Department of Health and Environmental Sciences
John North, Governor's Office

SUMMARY OF GROUND WATER ADVISORY COUNCIL RECOMMENDATIONS

Following is a summary of recommendations pertaining to ground water in Montana. This listing results from a two-year study by the Ground Water Advisory Council, a task force appointed by Governor Schwinden. Those actions needed to carry out the recommendations are identified, with emphasis on enactments and appropriations requiring legislative approval. The page numbers refer to sections of the full report providing a more detailed discussion of each issue.

The Issues	The Council's Recommendations	The Legislative Actions Needed	More Information
Ground Water Use Opportunities	Develop a publication to educate the public on ground water use opportunities and responsibilities.	Appropriate $1,500 to the Department of Natural Resources and Conservation for printing and distribution of the publication.	Pages 25-27
	Form an information center for the central organization and management of all ground water data collected state-wide.	For the ground water information center see "Legislative Action Needed" under "Ground Water Data and Information Needs."	
Conjunctive Surface Water and Ground Water Use	Identify opportunities for conjunctive use and establish site-specific research/data-gathering efforts to take advantage of these opportunities.	Appropriate $5,000 to the Montana Bureau of Mines and Geology (MBMG) to assemble a report on conjunctive use opportunities.	Pages 28-31
	Support the U.S. Bureau of Reclamation's demonstration artificial recharge program.	None. (DNRC will act as liaison)	
Aquifer Depletion	Identify specific areas where aquifer depletion is--or could become--a problem; and evaluate data needed to determine severity of the problem.	Appropriate $5,000 to the DNRC to assemble a report on actual and potential aquifer depletion problems.	Pages 32-35
	Use existing controlled ground water area statutes as necessary to deal with aquifer depletion.	None	
Interstate/International Ground Water Allocation	Gather data on ground water quality and quantity and characteristics of aquifer systems shared with other states or nations.	Appropriate $21,000 to the MBMG to purchase, install, and maintain recording equipment to monitor a buried Missouri River channel aquifer in northeastern Montana and the Madison aquifer.	Pages 36-38
	Approach the Canadian provinces of Alberta and Saskatchewan on beginning a mutual data-gathering effort on shared aquifer systems.	None.	
Water Well Driller Qualifications	Clarify the legal distinction between water well drillers and water well contractors, require licenses for both contractors and drillers, and request that the Board of Water Well Contractors consider moving intact from the Department of Commerce to DNRC.	Approve proposed legislation to clarify the difference between water well contractors and drillers, extend the licensing requirements to all drillers and contractors, and (possibly) transfer the Board of Water Well Contractors to DNRC.	Pages 39-41
	Increase the professional staff of the Board of Water Well Contractors.	Appropriate $60,000 for the biennium to the Board of Water Well Contractors to fund its staff and operations.	
	Set up a continuing education program for all water well drillers and contractors operating in the state.	None.	
Well Construction Standards	Give the Board of Water Well Contractors statutory authority to adopt comprehensive well construction standards.	Approve legislation to give the board this authority.	Pages 42-45
	Adopt mandatory comprehensive well construction standards and enforcement procedures.	None. (Action is instead required of the Board of Water Well Contractors.)	
Well Interference	Assure adequate well penetration into aquifer to avoid well interference problems.	None.	Pages 46-48

The Issues (cont.)	The Council's Recommendations	The Legislative Actions Needed	More Information
	Use controlled ground water area statutes to deal with well interference problems.	None.	
Ground Water Quality and Quantity Interaction	Allow formation of controlled ground water area in response to water quality degradation caused by excessive withdrawals and contaminant migration.	Approve legislation to modify the controlled ground water area statute.	Pages 49-50
Ground Water Data and Information Needs	Support the Water Development and Legacy fund grant applications submitted by MBMG to obtain funding for the Ground Water Information Center during the 1986-87 biennium.	Approve grant applications submitted to both Water Development and proposed Legacy programs.	Pages 52-55
	Request that the University System include, as part of its 1988-89 budget, sufficient funding to sustain the Ground Water Information Center.	Send resolution to governor and University System.	
State-wide Assessment of Ground Water Quality	Assess state-wide ground water quality in the major aquifer systems.	Appropriate funds as needed by MBMG over the next three bienniums.	Pages 57-61
Spills and Underground System Leaks	Support creation of a clean-up fund for accidental spills and leaks.	Approve legislation and Legacy program funding to set up emergency clean-up fund.	Pages 62-64
	Support system requiring measures to prevent leaks and monitoring for leaks for both existing and new tanks/pipelines.	None anticipated this session.	
	Support an inventory system to locate abandoned, existing, and new storage tanks.	None anticipated this session.	
Ground Water Contamination from Reserve Pits	Assess the extent to which presently accepted reserve pit reclamation procedures threaten ground water quality.	No legislative action in needed--the Ground Water Advisory Council will send a letter to the Board of Oil and Gas Conservation requesting the assessment.	Pages 65-67
Saline Seep Control	Stabilize the state's share of funding to the Triangle Conservation District.	Approve budget proposal to fund an expanded Triangle Conservation District.	Pages 68-71
Hazardous Waste Disposal	Evaluate the need for--and feasibility of--developing a commercial hazardous waste collection, transport, and disposal system within the state.	Support legislation and Legacy program funding recommended by Department of Health and Environmental Sciences and Environmental Quality Council to establish a commercial hazardous waste collection and transport system in Montana.	Pages 72-75
Interagency Coordination	Support the Ground Water Information Center as a means of avoiding duplication in data-gathering.	Approve grant aplications submitted to Water Development and proposed Legacy programs by MBMG for the Ground Water Information Center.	Pages 77-79
	Encourage EQC to work with Montana State University's Water Resources Research Center Advisory Council for improved interagency cooperation in research and data-gathering.	None.	
	Require that a standard set of ground water data be sent to GWIC by all parties who conduct ground water studies with state money.	None.	

GROUND WATER USE IN MONTANA

Ground water comprises only a small percentage of the total water used for consumptive purposes in Montana. The actual amount of ground water use is difficult to tabulate, because many diversions--particularly those for rural, domestic, agricultural, and stock water uses--are not metered and therefore can only be estimated. A state-wide ground water withdrawal rate of 293,000 acre-feet (af) per year has been estimated (Noble, et al [1982]). Total water withdrawals in Montana were estimated at 15,750,000 af in 1980; thus, ground water withdrawals probably account for about two percent of the total water withdrawn in Montana for non-hydropower purposes (Montana Department of Natural Resources and Conservation, 1984).

The number of people who rely on ground water continues to increase, however. Since 1974--the first complete year for which accurate water use permit information is available--over 84 percent of all water permits issued were for ground water development. An average of 3,800 ground water use permits have been issued annually by DNRC since 1974. Most have involved withdrawals of less than 100 gallons per minute for domestic and stock watering purposes. Still, permit information suggests that 14 percent of the irrigated land developed since 1973 is supplied by ground water. As much as fifty-two percent of ground water is used by self-supplied industry and 39 percent is used by the public, according to 1980 surveys (Montana Department of Natural Resources and Conservation, 1984). Finally, almost all rural domestic water needs are fulfilled by ground water (Montana Department of Natural Resources and Conservation, 1984).

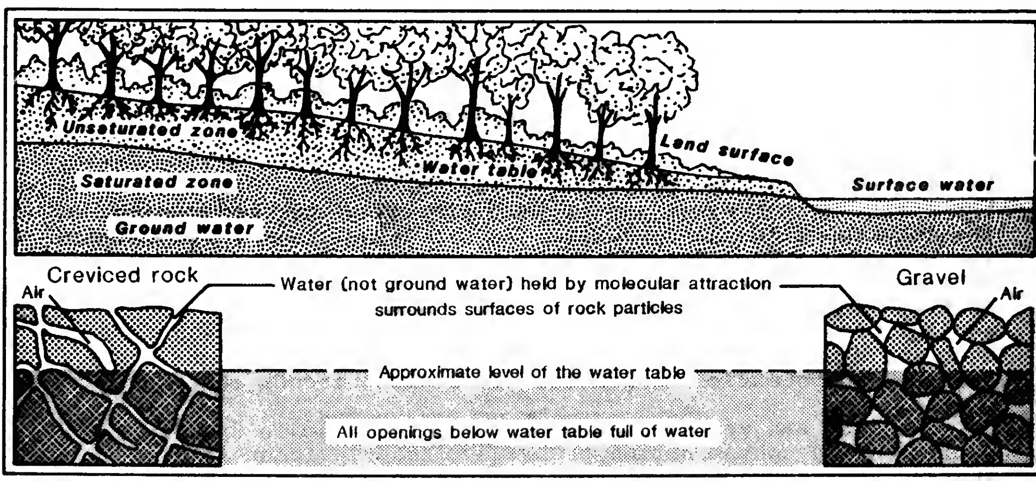
The significance of Montana's ground water resource cannot be measured by these statistics alone, however. In many areas of the state, ground water is the only source of supply, magnifying its importance to those who rely on it. As surface water becomes increasingly appropriated, ground water will be considered an alternative source. Water use has been increasing in all sectors--industrial, municipal, rural domestic, and agricultural--and ground water use is expected to increase also. Even so, Montana will use only a small part of its ground water development potential if present development trends continue.

Montana has yet to experience on a large scale the aquifer depletion and contamination problems already evident in other states. Partly because of this, Montanans have exhibited a certain complacency towards this resource when compared to their interest in surface water. This report and the recommendations contained within it are aimed at inspiring more active involvement by the state and its citizens in the protection and development of our ground water resources.

Many people think of ground water as underground lakes or streams. There are such things--in areas of cavernous limestones or volcanic lava flows--but mostly, ground water is simply water filling small spaces between rock grains or in cracks and crevices in rocks. Such openings are most common near the land surface; at great depth they are closed by the pressure of overlying materials.

The source of ground water is precipitation. When rain falls or snow melts, plants and soils take up water. Some water evaporates to the atmosphere from plant leaves, some runs off to streams, and some percolates down into the pores or cracks in rocks. The first water that enters the soil replaces water that has been evaporated or used by plants during a preceding dry spell. After plants and soil have had enough water and if rain continues to fall or snow continues to melt, the excess water will drain to the "water table"--the top of the zone in which openings in geologic units are saturated (Figure 1). Below the water table, all the crevices and pores are full of water.

Figure 1. How ground water occurs in rocks



From : Water Fact Sheet - Regional Aquifer Systems of the United States, U.S. Geological Survey, 1983.

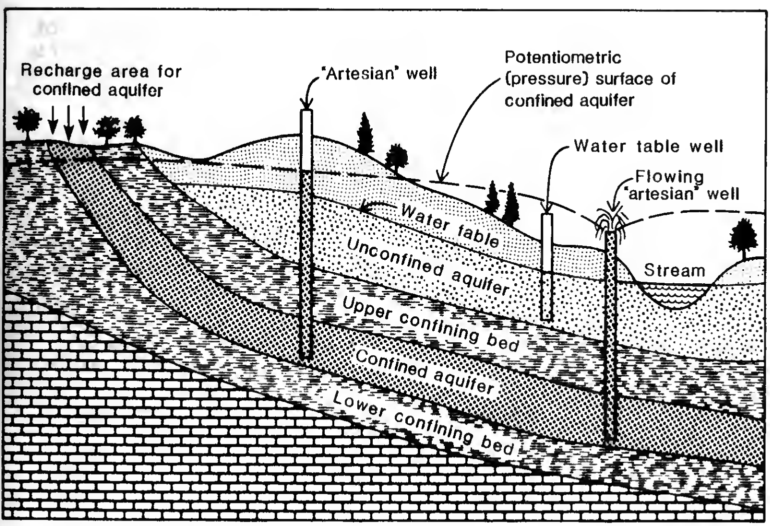
Between the land surface and the water table is a zone that hydrologists call the unsaturated zone (Figure 1) in which there is usually at least a little water, mostly in smaller openings of the soil and rock. The larger openings in the zone at times contain mostly air instead of water. After heavy precipitation,

the zone may be almost saturated; in a long dry spell, it may become drained and almost dry. In this zone, some water is held in the soil and rocks by molecular attraction, and it will not flow toward or enter a well. This is similar to a wet towel holding enough water to make it feel damp after it has stopped dripping.

The saturated zone of a geologic unit is more frequently referred to as an aquifer. An "aquifer" is best defined as an underground, saturated, permeable, geologic formation capable of producing significant quantities of water to a well or spring. It is the ability of the saturated zone, or a portion of that zone, to yield water to a well that makes it an aquifer. Aquifers function in two very important ways: (1) they transmit ground water from the point of entry to points of discharge, and (2) they provide storage for large volumes of water.

Two types of aquifer exist: unconfined and confined. An unconfined aquifer is near the earth's surface and is not overlain by impermeable geologic units. It also is known as a water-table aquifer because the water table is its upper boundary (Figure 2).

Figure 2. Unconfined and confined aquifers



From : Ground Water and Wells, UOP Johnson Division, 1966.

AQUIFERS

Aquifers consist of permeable rocks or granular deposits that transmit water freely. They function both as conduits and as underground storage reservoirs.

Confined aquifers usually occur further below the ground surface. They are wedged between impermeable geologic units such

as clays or shales; consequently, the water contained in the aquifer can be under pressure. These aquifers are often referred to as artesian or pressure aquifers. Many artesian aquifers continue for a long distance, becoming unconfined where the overlying impermeable unit ends--usually at the earth's surface (Figure 2).

The amount of water a geologic unit can contain depends on its porosity, which is a measure of the open spaces within that unit. Productive aquifers, such as sand and gravel, are often granular with numerous spaces between the grains. But, even in solid rocks like granite and other crystalline rocks, extensive fractures can be present that catch, store, and transmit ground water.

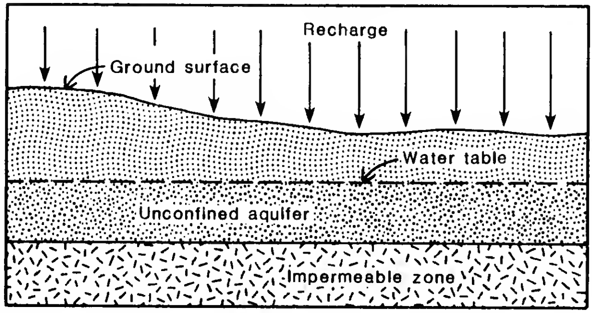
For a geologic unit to be a good aquifer, however, water must move freely through it. In order for water to move freely, the openings in the geologic unit must be interconnected, and the openings large enough so that friction does not greatly impede flow. If a geologic unit has many connected openings of a size sufficient to permit water to move freely, the unit is termed permeable. Large volumes of water can be pumped from permeable saturated materials. Even crystalline rocks with no intergranular spaces, such as granite, may be permeable if broken by crevices of sufficient size to permit water to pass freely. Clay and similar fine-grained materials have many small spaces between grains, but yield water very slowly because their pores are so small that wall friction greatly impedes water movement.

Aquifers are commonly classified by the geologic material of which they are composed. Seldom uniform in composition, aquifers may well be a mixture of several materials. Sands and gravels compose nearly 90 percent of all aquifers developed for water supplies. Porous sandstone, limestone, and highly fractured crystalline and volcanic rock are also common aquifer materials.

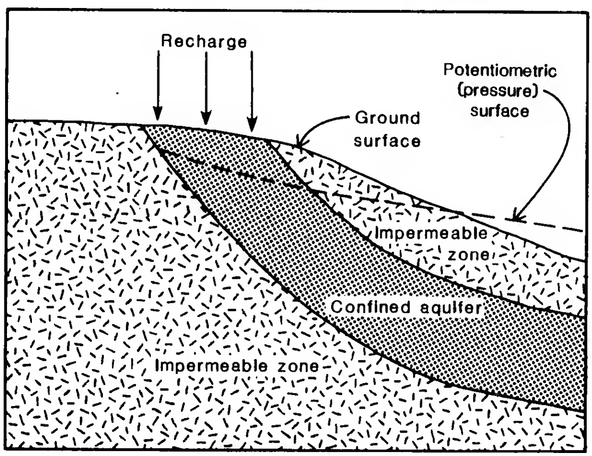
The zone where water enters an aquifer is called the recharge area. Water enters as precipitation or infiltration from surface waters (e.g., overlying streams and lakes), flowing through the pore spaces at an imperceptible, yet unceasing pace. Unconfined aquifers generally receive recharge from all along their surfaces, since they are not generally overlain by impermeable material (Figure 3a). Confined aquifers generally receive significant recharge only in areas where the impermeable unit is absent and the geologic units composing the confined aquifer are exposed at the surface (Figure 3b). Some recharge can also occur by leakage of ground water from overlying or underlying aquifer systems.

Figure 3. Aquifer recharge to confined and unconfined systems

a) Recharge to unconfined aquifer such as river valley alluvium



b) Recharge to confined aquifer such as a deeply buried bedrock aquifer



After entering an aquifer, water generally moves to lower-lying areas where--if not first intercepted by a well--it emerges from the ground water system in a discharge area, commonly a lake, spring, wetland, or river. The rate of ground water movement depends in part on the aquifer's permeability. The rate and direction of ground water flow also depend on the slope of the water table or pressure surface, known as the hydraulic gradient. Ground water moves from areas where the water table or the pressure surface is high in elevation to areas

where it is low. Steeper gradients cause faster ground water flow. Even so, ground water flow velocities are much lower than those of surface water in a stream or river, often ranging from several inches to several feet per day. Thus, it may require tens, hundreds, or thousands of years for ground water to travel between recharge and discharge points, depending on the length of the flow path.

Construction of a well and installation of a pump are the most common means of collecting and withdrawing ground water. Think of a well as an extra-large pore in the aquifer into which gravity (in an unconfined aquifer) or pressure (in a confined aquifer) forces new water as water is removed. If the well is pumped, gravity or pressure forces water to move from the surrounding saturated material into the well to replace pumped water.

The water level in a well tapping an unconfined aquifer rises only to the level of water within the aquifer but not higher than the top of the aquifer itself (Figure 4a). Drilling a well into a confined aquifer, however, is like puncturing a pressurized water pipe, with water under pressure flowing into the well and filling it to a level above the top of the aquifer (Figure 4b). Where the water level in a well tapping a confined aquifer rises to or above the ground surface, the well is said to be a flowing well.

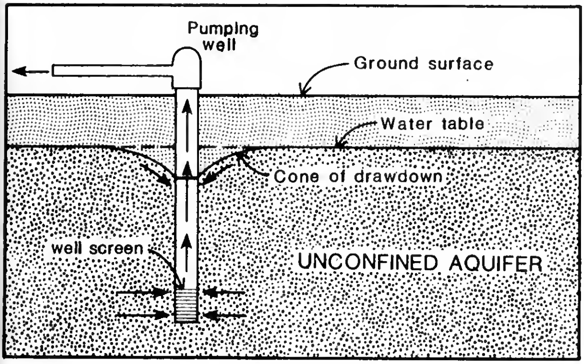
The inevitable consequence of withdrawing ground water is a change in the amount of water stored underground near the point of withdrawal. The most common effect of pumping is a decline in water levels, or "drawdown." The magnitude of the water level decline depends on both the rate of withdrawal and the properties of the aquifer. As pumping continues, drawdown will spread over an ever-increasing area, eventually reaching areas of recharge or discharge. As time progresses, a new equilibrium may be reached in which the pumping rate is balanced by increases in natural recharge or decreases in natural discharge. When that occurs, water levels will remain stable.

Water underlies the earth's surface almost everywhere. However, to locate ground water accurately as to depth, quantity, and quality, several techniques must be used to determine hydrologic and geologic features affecting the availability and quality of ground water.

The landscape may offer some clues to the geohydrologist about the occurrence of shallow ground water. Favorable conditions for this occurrence are more likely under valleys than under hills. In some regions, the presence of "water-loving" plants, such as cottonwoods or willows, indicates ground water at shallow to moderate depth. Any area where water persists at the surface as springs, seeps, swamps, or lakes reflects the presence of ground water, although not necessarily in large quantities or of usable quality.

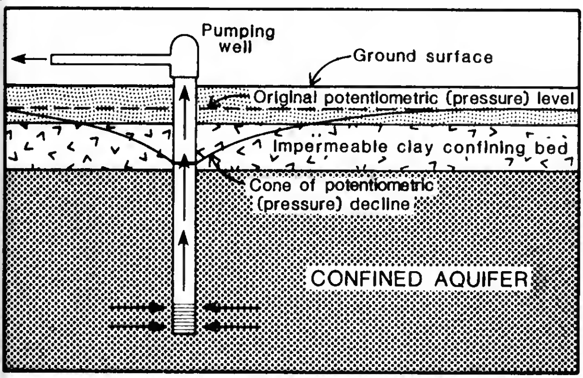
Figure 4. Aquifer response to pumping

a) Unconfined aquifer



When atmospheric pressure is freely communicated to the zone of saturation, the aquifer is called "unconfined". Unconfined aquifers yield water by drainage of materials near the well. Wells produce water by lowering the water level, causing water to flow radially toward the well.

b) Confined ("artesian") aquifer



Where an impermeable layer, such as clay, above the aquifer prevents free movement of air and water, the aquifer is called "confined" or "artesian". Confined aquifers yield water by compression of the aquifer, expansion of the water, drainage of adjacent unconfined zones, and leakage through confining layers.

From : Ground Water Issues and Answers, American Institute of Professional Geologists, 1983.

Geologic clues are the most valuable clues of all. As a first step in locating favorable conditions for ground water development, the geohydrologist prepares geologic maps and cross sections showing the distribution and positions of the different kinds of units both on the surface and underground. Much of this information comes from geologic well logs already drilled through the units in the area.

Next, the geohydrologist obtains information on the wells in the target area--their locations, depth to water, and the amount of water pumped. If there are no wells in the area, or if information on existing wells is insufficient, wells may be required. Although expensive, test wells can help to determine the amount of water moving through the aquifer, the volume of water that can enter wells, and the effects of pumping on water levels in the area. Because water quality is as important as water quantity, the geohydrologist may take samples of water from different wells and samples of the rocks through which the water flows for chemical analysis.

AGENCY RESPONSIBILITIES IN GROUND WATER MANAGEMENT

The complexities of ground water management are underscored by the numerous state and federal agencies as well as academic institutions that have responsibilities in the area. This chapter briefly describes the role of each of these institutions in the management of, and collection of data on, ground water resources in Montana. It should give the reader a general understanding of the existing legal and administrative framework of ground water management in Montana.

State Government

Montana Department of Health and Environmental Sciences (DHES)

Among this agency's many responsibilities are the preservation of ground water quality and the protection of the health and safety of those who rely on ground water for consumption or other purposes.

The Solid Waste Management Bureau (SWMB) regulates the siting and operation of sanitary landfills and hazardous waste disposal facilities. Both can be sources of ground water pollution. Since 1977, landfills have been licensed by the bureau under the Solid Waste Management Act. Bureau personnel must establish the physical suitability of the site for waste disposal before the license is issued. A review of operational plans to assure their compliance with established criteria is also required. Ground water pollution problems arise with greatest frequency in landfills constructed before creation of the licensing program. In dealing with actual or potential ground water pollution problems caused by landfills, the bureau can require installation of monitoring wells, collection of baseline data, and closure of the site or construction of remedial measures to eliminate the problem. There are presently about 225 licensed solid waste disposal facilities in Montana.

SWMB also administers the Montana Hazardous Waste Act, modeled after the Federal Resource Conservation and Recovery Act (RCRA). These regulations establish standards for the generators and transporters of hazardous wastes and require a permit issued by the bureau for waste storage, treatment, and disposal facilities. They also dictate how those sites should be monitored. At present, there are eight licensed, hazardous waste management facilities in Montana. All are noncommercial, meaning that they are used only for handling wastes generated by the owner/operator. These sites are closely monitored and the data are available to the public. Generators of toxic or hazardous wastes who do not operate their own disposal sites must currently ship those wastes to sites out of state to properly dispose of them.

The Water Quality Bureau of DHES regulates the quality and use of ground water in several ways. It administers Montana's public water supply laws. It regulates the location, construction, and operation of public water supply systems. (A public system is defined as one serving 10 or more families, 25 or more persons daily, or one with at least 10 service connections that are used for a minimum of 60 days out of the calendar year.) All plans and specifications for a public water supply system must be reviewed and approved by the bureau before construction. The primary purpose of the program is to assure that water used for human consumption is of acceptable quality.

The Montana Water Quality Act--also administered by the bureau--provides protection to all state waters, both surface and ground water. It requires the classification of waters according to their present and future most beneficial use and the establishment of standards of purity to protect these beneficial uses. The act also contains a nondegradation policy to prevent further degradation of those waters where existing quality is higher than that required by the standards. To carry out these responsibilities for ground water, the Board of Health and Environmental Sciences has developed the Montana Ground Water Pollution Control System. This system allows for classification of ground waters in a specific region by the bureau when someone proposes an injection well, landfill, or some other facility that could affect ground water quality in that area. The rule also includes a permit system for the containment or disposal of non-hazardous wastes that could pollute state ground water. Also included are provisions for emergency powers to protect ground water from contamination due to spills or unanticipated discharges of any material that would lower the quality of ground waters below applicable standards.

The Water Quality Bureau administers the Montana In-Situ Mining of Uranium Control System (MIMUCS). This program is designed to protect ground water from degradation associated with solution mining, where chemicals are introduced into a well field in order to extract uranium from underlying deposits. While there has been no large-scale in-situ mining of uranium in the state to date, this program will be important in dealing with future mining activity.

Finally, the Water Quality Bureau administers and enforces the Sanitation in Subdivisions Act. Under this law, plans for water supply systems, sewage treatment and solid waste disposal facilities, and storm-water runoff control must be reviewed and approved by the bureau before the subdivision is constructed. Before approval is granted, the applicant must prove that ground water pollution will not occur as a result of the development and that there is sufficient water available (usually ground water) to satisfy the needs of future residents. Administration of some parts of the act can be delegated to local authorities if the subdivision is of five or fewer parcels. A subdivision is defined as any land division creating parcels of less than 20

acres for development purposes, including mobile home parks, recreational vehicle camping parks, and condominiums.

No systematic collection of ground water data has been established by DHES. Rather, data are collected in response to specific proposals, problems, or complaints. These data focus on ground water quality, are organized by county, and are available to the public.

Department of Natural Resources and Conservation (DNRC)

DNRC's primary role in ground water management is in ground water quantity allocation through the water right permit system. It also promotes the wise use of ground water through loan and grant programs.

DNRC administers the Water Use Act. Under this act, persons desiring to use surface water, geothermal water, or ground water must receive a water right permit from DNRC. Permitting for ground water use is handled in two different ways, depending on whether or not the use is greater than 100 gallons per minute (gpm).

Where the appropriated amount of ground water will exceed 100 gpm, the user is required to submit to DNRC an Application for Beneficial Water Use Permit before any effort is made to develop the water supply. DNRC's Water Rights Bureau screens each application according to a list of criteria of issuance for a water right. These criteria require DNRC to evaluate water availability for appropriation when the applicant needs it, how other water users in the area will be affected by the proposed appropriation, and whether or not the proposed means of diverting or withdrawing the water is adequate. DNRC notifies other water users who could be affected by the proposed withdrawal, who are then given an opportunity to object to the proposal on their own behalf. If DNRC decides that an objection to an application may be valid, a public hearing on the proposed application is held. Usually the issue in question is water availability; each party attempts to demonstrate the water is or is not available for appropriation.

When DNRC issues a permit to appropriate water, it may attach such terms, conditions, restrictions, and limitations as it considers necessary to protect the rights of other appropriators. DNRC often sets conditions for the permit using the information presented in a hearing on objections. Conditions can take a number of forms--the amount requested may be reduced, or the appropriator may be allowed to divert only during specified times or required to check water availability before diverting. DNRC has limited power to enforce the conditions attached to a permit.

Ground water withdrawals for less than 100 gpm follow a considerably different process. For these appropriations, a permit is not required before withdrawing ground water. However, within 60 days of developing the supply and putting the water to beneficial use, the appropriator must file a form notifying DNRC that the appropriation has been completed. Once the information on the notification form is correct and complete, DNRC automatically issues a Certificate of Water Right to the appropriator. This part of the Water Use Act was designed to allow small-volume appropriators--principally domestic and stockwater users--to avoid the sometimes lengthy permit process.

As part of its water rights administration functions, DNRC's Water Rights Bureau keeps records of all water use permits issued since the Water Use Act became effective in July, 1973. Those records contain information on the location of the diversions and where the water is used, the volume and flow rate of the appropriation, the use to which the water will be put, and whether the appropriation is for surface water or ground water. The Water Rights Bureau also keeps records of well log reports describing the geologic strata penetrated during drilling and giving basic information on the location of the well, depth at which water was encountered, static water level, and depth of well. State law requires that the drillers submit these logs as part of the ground water appropriation process. A copy of the log is sent to the Montana Bureau of Mines and Geology.

DNRC also oversees a variety of other water rights that bear on ground water. For example, DNRC must approve changes of existing water rights regarding place of diversion, place or purpose of use, or place of storage before they occur. It also assists the Water Courts in the state-wide adjudication of pre-1973 water rights, including ground water rights. Records of all filings are maintained by DNRC.

In addition to regulatory function, DNRC manages programs that can provide financial and/or technical assistance in ground water studies and the development of ground water and geothermal resources. The Water Development Program created by the 1981 Legislature provides grants and low-interest loans for water-related projects and activities. The Renewable Resources Development Program provides loans and grants to units of local government for development of renewable resources, including water. Both have provided funds for ground water development or to support ground water resources investigations. The Rangeland Improvement Loan Program provides low-interest loans to livestock operators desiring to improve range conditions through a number of practices, which may include ground water development projects. The Geothermal Commercialization Program collects and distributes information about the state's geothermal resources including locations and opportunities for development as well as regulations governing geothermal development. Technical assistance in the development and use of geothermal heat or geothermally heated water is also provided.

The Board of Natural Resources and Conservation also has important responsibilities in ground water management. Under the board's authority, special controlled ground water management areas can be formed to deal with ground water problems. These areas can be formed if the board finds that ground water withdrawals exceed recharge, excessive ground water withdrawals are likely to occur, significant legal disputes regarding ground water rights are occurring, or ground water levels or pressures are declining or have declined excessively. Within these designated areas, the board has wide-ranging powers to limit the quantities, location, and timing of existing and future withdrawals of ground water.

The Board of Oil and Gas Conservation is attached to DNRC for administrative purposes. Its responsibilities include regulation of oil and gas wells to prevent the pollution of fresh water supplies by oil, gas, salt, or brackish water. Well logs from oil and gas exploration or production wells are kept on file at DNRC.

Montana Bureau of Mines and Geology (MBMG)

MBMG is a nonregulatory, research-oriented state agency attached to the Montana College of Mineral Science and Technology. MBMG responsibilities include the study of geologic and hydrogeologic resources within Montana.

MBMG is currently conducting 18 hydrogeologic investigations throughout Montana on coal hydrology, geothermal assessment, water quality problems caused by saline seep, surface and ground water interactions, acid mine drainage, and community or rural water problems. The majority of these projects are funded from nonstate sources.

MBMG maintains ground water information files and provides assistance in interpreting these data to the public. The files contain data on aquifer tests, observation well water levels, water quality, and well inventories.

Water well construction and completion data for more than 80,000 wells have been evaluated, coded, and placed in computer files. Data from the well logs completed by the well driller or owner include items such as location, owner, depth, yield, static water level, casing size, and driller's license number. Notations in the data include geologic source, water quality data and whether or not the location of the well has been field verified. In addition to recording the data, MBMG refines information on well location, identifies the geologic unit tapped by the well and computes elevation data for well depth, aquifer depth, and static water level.

Department of Commerce

The Board of Water Well Contractors (BWWC) is currently housed in the Department of Commerce for administrative purposes. The board is composed of five voting members, including one technical advisor--usually a hydrogeologist--appointed by MBMG, two licensed Montana water well contractors appointed by the governor, one DNRC representative, and one DHES representative. The board administers and enforces a mandatory licensing program for water well contractors operating within the state. It also handles complaints from the public against water well drillers on such matters as improper well construction, dry wells, money settlements, and falsified well logs. Finally, it has limited authority to adopt and enforce rules on construction procedures and materials requirements for wells drilled by contractors. The board's professional staff consists of a one-half time inspector.

Department of State Lands (DSL)

DSL enforces the state's reclamation statutes concerning mineral extraction activities; it has the authority to protect ground water resources from adverse impacts related to mining. Under the Strip Mining Act, and the Metal Mine Reclamation Act, mining companies may be required to conduct site-specific, pre-mining ground water studies and continue to monitor ground water during and after mining until reclamation is complete. Mining companies are often required to collect information on the quality of water within affected aquifers, and ground water levels in the area to comply with the law. DSL maintains and makes available for public use the mining company reports and all the data contained therein.

Federal Government Agencies

Environmental Protection Agency (EPA)

Under the Federal Safe Drinking Water Act, EPA oversees the Drinking Water Program administered in Montana by the Montana Department of Health and Environmental Sciences. The program is aimed at monitoring the chemical and biological quality of public water supplies to help assure that water consumed by the public meets minimum health and quality standards. Data on community supplies are maintained at DHES, while EPA maintains data for water supplies on Indian reservations.

Also under the Safe Drinking Water Act, EPA, working with the Oil and Gas Conservation Board (DNRC) and DHES, regulates through a permit process the injection of waste water into aquifers for disposal. A primary intent of the program--called the Underground Injection Control Program--is to minimize the

chances for aquifer contamination by fluids associated with oil and gas production.

EPA also administers the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, more commonly known as the "Superfund Program." This program authorizes spending federal funds to restore the quality of ground water contaminated by surface or subsurface disposal of wastes. So far, six sites in Montana have been identified as eligible for these funds. DHES assists the EPA in administering this program in Montana.

EPA has developed a ground water protection strategy for the nation. The strategy emphasizes the need to (1) determine the actual extent and severity of the ground water contamination problem in the country, and (2) more closely regulate the design and construction of surface impoundments, landfills, and storage tanks to minimize the chances of ground water contamination from these sources. The programs and funds that arise under this program will assist Montana in controlling ground water contamination.

U.S. Geological Survey (USGS)

USGS is a nonregulatory agency that maintains a water resources program designed to collect and disseminate data, and conduct problem-oriented water resource appraisals, interpretive studies, and research in the field of hydrology. The agency deals extensively with both surface and ground water resources. The vast majority of work carried out by USGS is done at the request of local or state governments or other federal agencies. The federal agencies fully fund studies performed at their request while state and local agencies usually provide 50 percent of funds for projects under the USGS cooperative program.

A state-wide ground water observation well network--called SWON--is maintained to monitor water levels in various areas throughout Montana. Most of the 200 wells in the system have several years of data on static water level. Some wells are also used for water quality monitoring. All data can be accessed by computer at the USGS office in Helena.

Ground water information from SWON as well as from the research activities carried out by USGS is entered into the National Ground Water Site Inventory (GWSI) computer file. Information on file includes the location of the well by township and range as well as latitude and longitude, the well owner, well depth, casing length, perforation intervals, aquifers penetrated, well yield data, quality of water from the well, aquifer characteristics, and borehole lithology.

Interpretive studies and results of research activities are published in reports available for public use.

University System

University of Montana

Both a Master's and Doctor of Philosophy degree with an emphasis on hydrogeology are available through the Geology Department. Coursework at the University of Montana includes basic and advanced hydrogeology, a seminar in hydrogeology, and related training in geology, geophysics, chemistry, and hydrology.

Hydrogeologic data are collected in connection with research projects performed by faculty and students. Ground water is the subject of five master's theses that are--or will soon be--completed; one deals with arsenic contamination at Milltown, another with oil brine pit reclamation techniques and their impact on ground water in northeastern Montana, a third concerns ground water/shoreline interactions on Flathead Lake and related salmon spawning success, and two with specific hydrogeologic resources of the Bitterroot Valley. Specific hydrogeologic resources may also be the subject of "senior problems" (research performed by undergraduates).

Montana State University

Students at Montana State University can receive a Master's degree with an emphasis on ground water from the Civil Engineering Department or the Earth Sciences Department. These two programs differ substantially in the approach used. As a result a student has an opportunity to obtain a strong multi-disciplinary understanding of the subject.

Research on ground water is also multi-disciplinary, and is often funded in cooperation with other state and federal agencies. One current project of the Civil Engineering Department concerns irrigation return flows in the Dillon area; another, a six-year study funded by the EPA, examines the effects of coal mining in southeastern Montana. MSU serves as the lead unit in the latter project, with the University of Wyoming and North Dakota State University as cooperators. Pre-mining baseline data were obtained at one site in each of the three states, with the East Decker and Tanner Creek area selected in Montana. Using post-mining data and the disciplines of hydrology, chemistry, and soils, impacts on the quality and quantity of both ground water and surface water are being assessed. Numerous journal articles have resulted from this research, as well as a final report on the project findings.

Researchers in the Earth Sciences Department have cooperated with the DHES Solid Waste Bureau and MBMG to study ground water problems at landfill sites across Montana. A current project with the USGS studies geothermal potential in the state, and a

study of ground water potential for laboratory and irrigation use has been completed for the MSU campus.

Montana University Joint Water Resources Research Center

The main office of this organization, which is a part of the university system, is located at Montana State University in Bozeman, with coordinators in Butte and Missoula. The purpose of the center is to foster research in water resources. It does this by working with state government agencies to identify a problem, and then finding faculty members to develop a study design. Graduate students sometimes conduct the research. Funding has been provided by various state agencies as well as the U.S. Geological Survey. Several current studies relate to ground water.

Montana College of Mineral Science and Technology

Most ground water activities, other than coursework, are conducted through MBMG. Because MBMG is actually a state agency located within the college, its research and data management functions are presented in the "State Government" section of this chapter.

THE ISSUES

The Ground Water Advisory Council was divided into four subcommittees to address issues within the areas of integrated ground water management, ground water data and information needs, ground water quality management, and interagency coordination. Each subcommittee identified the issues of greatest importance within its area of expertise, developed background information, and presented options and draft recommendations to the full Council. In the end, the Council adopted recommendations on each of the issues brought before it. Those issues and recommendations are summarized in the following sections. Each recommendation includes the reasons for it, who should carry out the recommendation and any legal or financial requirements if the recommendation is to be followed.

INTEGRATED GROUND WATER MANAGEMENT

Subcommittee Members:
Gary Fritz, Chairman
Jack Galt
William Osborne
Stephen Custer

GROUND WATER OPPORTUNITIES

Ground water has tremendous potential economic value to Montana as a source of water to satisfy agricultural, municipal, and industrial needs. In the search for solutions to a problem, however, funds are rarely committed to examine potential ground water alternatives, though surface water development in some cases can be much more expensive and less dependable than using ground water either by itself or with surface water.

Possible opportunities for the solution of water-related problems through the use and management of ground water abound:

-- In northeastern Montana (Sheridan, Daniels, and Roosevelt counties), an ancient abandoned channel of the Missouri River lies hidden underneath glacial outwash deposits. Gravel beds in the channel can yield large amounts of water to wells but development of the aquifer for irrigation has been slow and haphazard, discouraged by a lack of information on the aquifer's geographic extent, storage, and water quality, as well as by fears of over-development. A cooperative study between Sheridan County, MBMG, and USGS is in progress and is aimed at answering some of these questions.

-- Along the lower Big Hole River, irrigators using surface water face severe and unpredictable shortages late in the irrigation season. The engineering remedy considered was construction of an off-stream reservoir in the upper reach to store runoff for use during low-flow periods. An alternative to reservoir construction may be the installation of high-capacity wells along the upper reach to augment the river during times of low flow. The aquifer in the upper reach could then serve as a natural reservoir that would be recharged during periods of high runoff. This conjunctive use of surface and ground water has not been seriously considered, principally because of the lack of hydrogeologic data needed to determine its feasibility.

-- Severe erosion problems in Muddy Creek caused by irrigation on the Greenfield Bench along Muddy Creek (Teton and Chouteau counties) are creating the most serious water quality problem in the state. Ditch flows for sprinkler irrigation are by-passed into Muddy Creek during periods of high natural precipitation. These flows, when added to the natural flow of Muddy Creek, overload the stream channels and severe streambank erosion results. Possible remedies for this problem include construction of a sedimentation reservoir on Muddy Creek and the lining of irrigation ditches on the Greenfield Bench to reduce the ground water discharge to Muddy Creek. Another possible solution is to leave the upstream ditches unlined, which would encourage recharge to the ground water system rather than runoff from

excess irrigation water, and install high-capacity wells or ground water drains to provide irrigation water on the lower portions of the Greenfield Bench. The re-use of ground water could reduce irrigation return flows to Muddy Creek and subsequently moderate the streambank erosion problem.

-- The City of Bozeman has a water shortage problem. The city is currently using nearly all the surface water rights available to it; a turbidity problem each spring may introduce an additional health hazard. To respond to these problems a new water plant is being constructed. Historically, the city has relied on surface water, but ground water sources might include water from subsurface alluvial valleys if adequate recharge can be identified. The Madison aquifer is another possible ground water source that could augment the city's water supply and reduce or eliminate the spring season contamination problems.

It is often difficult to plan for the development of ground water because of inadequate data on ground water resources in some areas of the state. Published reports by MBMG and USGS cover only a portion of the state's ground water resource; many reports require updating. Evaluation of the possibility for ground water development requires a site-specific approach in areas not covered in previous studies or covered only generally. Securing this detailed information can be costly and time-consuming to the individual in search of a solution to a water problem.

A complicating factor is that much of the existing data on ground water is disorganized and inaccessible. Useful data has come from a variety of different sources, including the Oil and Gas Commission, DNRC, MBMG, USGS, and the universities; yet the lack of a central repository for the data makes securing that data tedious and time-consuming. If data were easily available, ground water development would more often be considered a viable alternative to surface water development.

Finally, the general public, as well as many public administrators, is not yet accustomed to considering ground water as a solution to water-related problems.

Council Recommendations

The Council recommends that an educational publication be produced and distributed to increase public awareness of ground water development opportunities as well as to make the public aware of its responsibility to protect the ground water resource. The pamphlet would be produced by DNRC staff and distributed through DNRC as well as University extension offices. The publication would address topics such as the importance of constructing a water supply well properly,

information on filing for water rights, and sources of information on ground water.

The Council also supports creation of the Ground Water Information Center as a central repository for all ground water data collected in the state. This concept is presented in detail in the chapter on Ground Water Data and Information Needs.

Why the Council Adopted the Recommendations

The Council believes that public education is the most desirable means of increasing public awareness of both the importance of ground water as a potential water supply and of ground water's development potential.

The Ground Water Information Center would provide a means of centrally locating and organizing data collected on the state's ground water resource. Without such an organization it is difficult to take advantage of information already available in the evaluation of ground water as a potential solution to a problem.

What is Needed to Follow the Recommendation

An information pamphlet could be written by DNRC staff. Approximately 6,000 pamphlets would be printed and distributed at a cost of $1,500. Thus, a legislative appropriation of $1,500 would be needed.

A detailed description of what is needed to create a ground water information center under the Montana Bureau of Mines and Geology is given on pages 52-55.

CONJUNCTIVE SURFACE WATER AND GROUND WATER USE

"Conjunctive use" refers to the use of surface and ground water resources in a basin to satisfy a given level of water demand in a cost-effective manner. In reaching this objective, a variety of factors is often taken into account, including the timing of water demand, the timing of surface water and ground water availability, and the cost of securing each type of water supply. If carried out properly, conjunctive use can potentially alleviate water shortages, use resources that are normally wasted or remain untapped, and aid in water conservation.

The most familiar form of conjunctive use is the artificial recharge of an aquifer through seepage ponds or injection wells (Figure 5). Artificial recharge refers to increasing the amount of available water in aquifer storage by artifically increasing the rate of infiltration into the aquifer. This technique has been used successfully in Fresno, California; Minot, North Dakota; and other locations throughout the country.

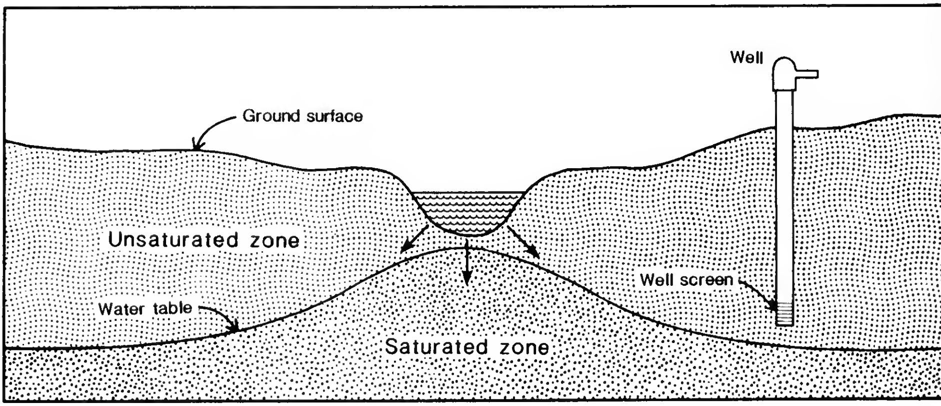
Artificial recharge may be beneficial if (1) ground water levels on an annual or seasonal basis are declining at an unacceptable rate, and an increased rate of aquifer recharge is desirable, (2) use of the storage capacities of an aquifer are preferable to construction of a surface water storage facility; or (3) use of the transmissive capabilities of an aquifer are preferable to construction of surface distribution systems.

Artificial recharge requires unappropriated surface waters to be available. Large quantities of unappropriated surface waters may not be available during most of the year due to intensive surface water development. However, flood waters from spring runoff frequently occur in sufficient quantities to be used for artificial recharge. When considering artificial recharge as a means of storing water, detailed, site-specific information is instrumental in determining whether recharged water will seep away or remain in storage until it is needed. When considering artificial recharge as a means of transmitting water, detailed information is needed to determine which way recharged water will flow and whether its flow behavior will tend to alter the accessibility of that water.

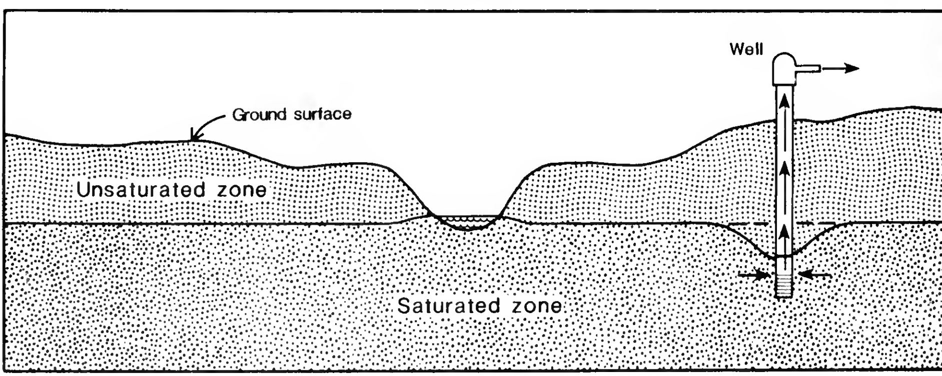
The withdrawal of ground water to supplement surface water flow is also a form of conjunctive use. Such a strategy could be utilized in a situation where ground water resources have not yet been developed and surface water flows during low-flow periods are insufficient to satisfy appropriators. Again, extensive site-specific data must be available. Questions must be answered regarding whether ground water withdrawals will deplete the surface water flow to be supplemented and whether ground water diverted into the stream will remain in the stream or be lost to seepage into the ground water system before it serves its supplemental purpose. Often too, land under one ownership would

Figure 5. Artificial recharge by seepage pond

a) Recharge of ground water when surface water is abundant (spring)



b) Withdrawal of ground water when surface water is scarce (summer)



provide the ground water to supplement a surface water supply for land under another ownership, requiring a regional approach to management.

Closely related to the conjunctive use program is the appropriation of dual water rights by an individual--one surface

water right and one ground water right. Each right may indicate the time of year the right could be exercised. A surface water right that allows diversion during high flow may be supplemented with a ground water right for low-flow periods. This program would be most successful if pumping were from a confined aquifer, which would not interfere with flow in nearby streams.

Conjunctive use is employed to a limited extent in Montana. The city of Missoula, for example, has long relied on both ground water and surface water sources to supply its municipal water needs. In other areas of the state, conjunctive use is being inadvertently practiced. There are many areas where ground water systems are being artificially recharged by leaking ditches and inefficient use of water for irrigation. The resulting increase in local ground water supplies is then tapped through the use of wells to supply water for other purposes, often domestic or agricultural. The developing dependency on this artificially recharged water can cause problems if water-distribution/ water-use efficiencies are suddenly increased, the associated artificial recharge is reduced, and ground water levels fall. This potential problem is of concern in the Bitterroot Valley, Gallatin River Valley, the Dillon area and many other valleys that now support flood-irrigated agriculture.

While the conjunctive use of ground and surface water resources is not specifically addressed in Montana water law, the present laws do allow its practice.

Council Recommendations

The Council recommends that MBMG, working with DNRC, the Montana University System and USGS, develop a report that identifies and evaluates opportunities for conjunctive use across the state and establishes site-specific research/data-gathering efforts needed to promote conjunctive use for each of the identified opportunities. This report should be made available to the general public and to state and federal agencies.

DNRC should identify and promote state support for federal program legislation that would create a demonstration artificial recharge project in Montana. Such a program is the U.S. Bureau of Reclamation's artificial recharge program, which proposes to allocate federal funds to assist in selecting sites for, and implementing artificial recharge demonstration projects in, each of the 17 western states.

Why the Council Adopted the Recommendations

The recommended report would identify both conjunctive use opportunities and the information needed to take advantage of those opportunities. The document would be of value in helping individuals as well as government subdivisions decide whether a

conjunctive use program could meet their needs. Second, the report would illustrate the types of concerns that should be addressed before conjunctive use is considered. Finally, the report would identify needed research that granting agencies can use in evaluating ground water study funding proposals.

A demonstration artificial recharge project in Montana would increase public awareness of conjunctive use of ground water as a viable alternative in resolving water supply problems.

What is Needed to Follow the Recommendation

A legislative appropriation of $5,000 for the 1985-86 biennium would be needed to support MBMG staff who will assemble the report. The funds should be appropriated through MBMG and will be allocated as follows:

Personal Services	$3,500
Travel	750
Supplies and Materials	250
Publication Costs	500
Total	$5,000

AQUIFER DEPLETION

Aquifer depletion refers to ground water shortage brought about by pumping more water from an aquifer than can be replaced by rainfall and snowmelt.

Water depletion within an aquifer can prohibit feasible use of the remainder of water in aquifer storage. Similarly, the pollution of ground water due to depletion which induces recharge from a contaminated source can also prohibit the use of remaining stored water. This discussion of aquifer depletion is limited to ground water quantity. The interaction between ground water quantity and quality is discussed in "Ground Water Quality and Quantity Interaction."

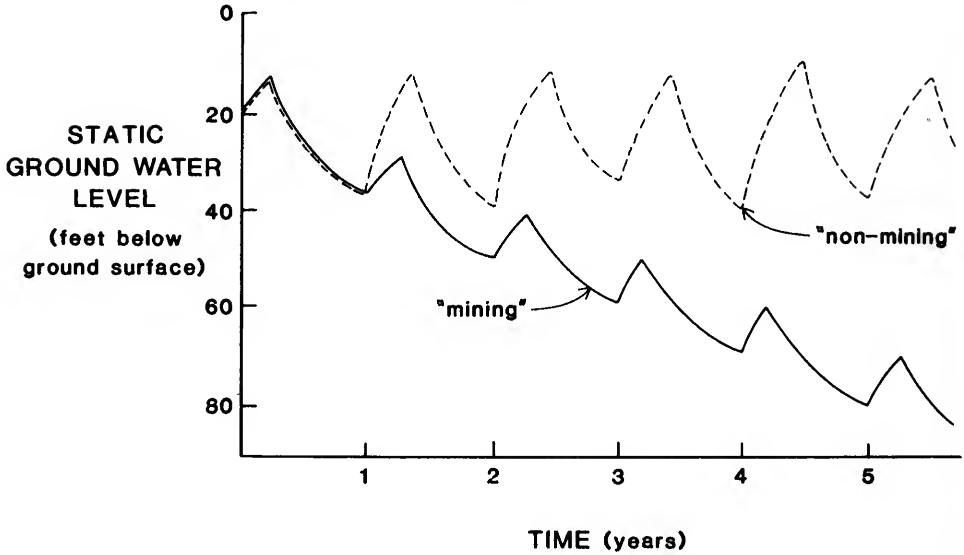
Before development, most ground water basins are in a state of dynamic equilibrium in which recharge approximates discharge. When discharge from the basin is increased by pumping, the equilibrium is disrupted. Equilibrium may then be restored through (1) an increase in recharge such as induced infiltration from a surface water body, or (2) a decrease in natural discharge such as a reduction in evapotranspiration, ground water leakage to other aquifer systems, or discharge to surface waters. Most often, equilibrium is restored through a combination of the two. Until equilibrium is restored, ground water levels will decline. When this decline causes pumping levels to fall below an acceptable limit, aquifer depletion becomes a serious economic and social issue.

Aquifer depletion, indicated by declining static water levels, often occurs during the summer months when natural recharge is low and pumping withdrawals are high. Static water levels are usually restored, however, during the subsequent spring when recharge is high and withdrawals are low (Figure 6).

A more serious aquifer depletion condition called "mining" occurs when ground water withdrawal rates exceed rates of recharge over a long time (Figure 6). The result is a trend of continuously declining static water levels. In the most severe circumstances, pumping withdrawals greatly exceed recharge and remove water that may never be replaced by natural processes.

The state of Montana can deal with aquifer depletion problems through the declaration of a controlled ground water management area. This special management area may be created by the Montana Board of Natural Resources and Conservation if (1) withdrawals exceed recharge, (2) excessive withdrawals are or may be occurring, (3) user conflicts are or may be occurring, or (4) water levels or artesian pressure are or may be declining "excessively." Within the designated bounds of the controlled ground water area, the board has the power to implement almost any management practices necessary to address the ground water depletion problems.

Figure 6. Ground water fluctuations reflecting "mining" and "non-mining" situations



The power of the state in the designation and management of controlled ground water areas is considered adequate to address ground water depletion problems. The major shortcoming of this scheme is the way in which it is used--a problem must exist before active management options are exercised. The tendency to use the state's management powers only after a significant regional depletion problem arises is due mainly to the lack of data necessary for early recognition of the problem, particularly the lack of data on recharge, locations and amounts of withdrawals, available water in aquifer storage, and aquifer hydraulic characteristics. In addition, the board is also very reluctant to use these management powers without overwhelming support from residents within the proposed boundaries--but such support usually develops only after a problem becomes a serious economic threat.

At this time, there are only two controlled ground water areas in the state; the South Pine controlled ground water area near Terry, Montana, and the Larson Creek controlled ground water area near Stevensville. Petitions submitted by groups interested in forming controlled ground water areas are becoming more common, however.

A potential problem in Montana's ground water management program is its approach in dealing with ground water mining. Present state statutes recognize ground water only as a resource that is replenished, not as a nonrenewable resource, as it can be in cases where recharge is very limited or nonexistent. The statutes are based on maintenance of reasonable pumping levels. This management assumes that all aquifer systems are recharged on an annual basis and that, with proper management, aquifer pumping levels can be maintained. In fact, withdrawals from aquifers for which recharge is minimal or nonexistent will inevitably result in a permanent decline of ground water levels.

Many other western states have more serious aquifer depletion problems than Montana's. In most of these states, aquifer mining is allowed and a "useful life" is placed on the ground water resource based on the time required for pumping of the aquifer to become economically unfeasible. For example:

- Colorado permits 40 percent depletion of tributary ground water resources in 25 years and 100 percent depletion of nontributary ground water basins in 100 years.

- New Mexico allows depletion of two-thirds of its aquifers in 40 years.

- Oklahoma allows 100 percent depletion of ground water basins within 20 years' time.

Once more, however, the effectiveness of these measures can be reduced by the lack of available information to define the resource and to distinguish accurately the effect of ground water withdrawals in reaching these targeted withdrawal volumes over the specified time.

Although large scale aquifer depletion problems are not confronting Montana at the present time, continued development of the state's ground water carries with it a risk of permanently reducing static water levels in some aquifer systems.

Council Recommendations

The Council recommends that the Montana DNRC, with assistance from MBMG, USGS and state universities, complete a report to identify specific areas in the state where aquifer depletion is or could become a problem, either because of heavy existing development or heavy anticipated development. Data collection needs should be identified for each area. The report would be used as a guide in allocating resources for future data collection which will provide a basis to help decide whether "mining" is acceptable or whether withdrawals snould be limited so they don't exceed the safe yield of the aquifer.

The designation of controlled ground water areas should be promoted to deal with known aquifer depletion problems.

Why the Council Adopted the Recommendation

Initiation of efforts to provide a good site-specific data base is important in the identification and management of aquifer depletion problems. The controlled ground water area statutes contain sufficient provisions to address ground water depletion problems once the problem is identified and a data base established.

Ground water depletion problems on a state wide basis are not currently of sufficient magnitude to justify legislation on the issue of aquifer mining.

What is Needed to Follow the Recommendation

A legislative appropriation of $5,000 for the 1985-86 biennium would be needed to support DNRC staff in assembling the report. The money should be appropriated through DNRC and will be allocated as follows:

Personal Services	$3,500
Travel	750
Supplies and Materials	25
Publication Costs	500
Total	$5,000

INTERSTATE/INTERNATIONAL GROUND WATER ALLOCATION

The allocation of ground water has not been addressed in any of Montana's interstate or international water resource compacts. The interstate allocation of ground water is a difficult subject to address in compact agreements because of the complexities involved in identifying the extent of the resource as well as the difficulty of equitable apportionment once its extent is determined. Thus, a considerable incentive is needed to seriously consider ground water allocation across major political boundaries. The incentive may be a forecasted or existing shortage of ground water in an interstate aquifer that could cause significant economic losses in one or more states.

Montana is not faced with an immediate need to enter into ground water compact agreements, but two aquifer systems bear watching for future problems--the ancestral Missouri River channels and the Madison aquifer. The Missouri River channels aquifer is shared with North Dakota and the Canadian province of Saskatchewan. Its potential importance as a stable, high-yielding source of good quality water for northeastern Montana has only recently been recognized. Hydrogeologic studies being conducted by the U. S. Geological Survey and the Montana Bureau of Mines and Geology are aimed at identifying the extent and development potential of this aquifer.

The Madison aquifer is large--it extends into portions of Montana, Wyoming, North Dakota, South Dakota, Utah, Idaho, and Canada. Much of the aquifer system exists under confined conditions, with wells tapping the aquifer frequently flowing at ground surface. Although deep, with variable water quality, this massive aquifer is important because it can play a significant role in the recharge of more shallow, overlying aquifer systems that many Montanans depend on for a water supply. In addition, the aquifer has been considered as a source of supply for some industrial and municipal uses. For example, Energy Transportation System, Inc. (ETSI) planned to withdraw large quantities of water from the aquifer in Wyoming to supply a proposed coal slurry pipeline. The impact of this and other high-volume withdrawals could have caused a substantial decrease in the quantity and/or quality of water available for existing and future uses in Montana's portion of the Madison aquifer.

The Madison aquifer has been the subject of an expensive study by the USGS under the Regional Aquifer Systems Analysis program. Under this program, USGS has drilled three deep holes through the Madison aquifer system to assess the aquifer's thickness, hydraulic/hydrologic character, and development potential.

International/interstate allocation of ground water may still be many years away. There are, however, several concerns that merit attention to ground water allocation on an

international scale. First, the process of allocation is lengthy, whether accomplished through equitable apportionment by the courts or through negotiation by the states and countries. For example, the Yellowstone Compact, which allocates surface waters of the Yellowstone River Basin between the signatory states of Montana, Wyoming, and North Dakota, required 17 years of negotiation to develop. Second, development of a sound allocation will only occur with adequate data. This is particularly true of allocations involving ground water because of the hydrologic and geologic complexities affecting its availability. Third, development of an adequate ground water data base, especially for deeply buried bedrock aquifers, will be expensive. Drilling costs of $100,000-$500,000 per hole or more are not uncommon to adequately penetrate some of these deeply buried bedrock aquifers that have potential interstate significance. Finally, the length of the record period of water level data is also important. A period of record of ten years is generally considered adequate, although longer periods are desirable.

Council Recommendations

The Council recommends that the MBMG, under the general direction of DNRC, should initiate an effort to gather data on ground water levels in--and hydrogeologic characteristics of--important interstate/ international aquifer systems. In addition, DNRC should initiate joint efforts with the Canadian provinces of Alberta and Saskatchewan to begin a mutual data-gathering program for aquifers shared internationally.

Why the Council Adopted the Recommendations

Although the need for interstate/international ground water allocation may not become apparent for many years, it is important to begin laying the technical groundwork for future negotiations now. Because of the expense of drilling new observation wells, monitoring efforts should, where possible, use existing wells.

What is Needed to Follow the Recommendations

MBMG is currently involved in a study with the Sheridan County Conservation District and USGS to obtain information on the outwash aquifer and a buried Missouri River Channel aquifer in northeastern Montana. Some of the observation wells drilled during this study are suitable for long-term monitoring of these interstate aquifers, once continuous recorders are purchased and installed. MBMG would need $11,000 to purchase ten recorders to monitor this aquifer system. The personnel required to prepare, install and maintain this equipment can be provided from existing staff.

USGS has drilled two deep holes into the Madison aquifer in southeast Montana as part of the Regional Aquifer Systems Analysis Study conducted in 1978. In cooperation with USGS, MBMG should engage in a program to monitor water levels and water quality in the Madison aquifer using these holes. MBMG would need a $10,000 appropriation for the coming biennium to finance its share of a cooperative effort to purchase, install, and maintain recording equipment for these deep wells.

WATER WELL DRILLER QUALIFICATIONS

Montana has about 260 licensed water well contractors, who are responsible for overseeing water well drilling operations and assuring proper development and construction of wells. Contractors may actually carry out the drilling themselves or they may elect to hire drillers who are not contractors to do some or all of the work required under a contract. Well-log records filed with DNRC show that about 2,500 wells supporting ground water appropriations are drilled each year.

The State of Montana requires licensing of water well contractors (MCA Chapter 47). These licensing requirements are handled through the Board of Water Well Contractors, which is housed in the Department of Commerce for administrative purposes. A contractor can obtain a license only by showing proof that he has completed a one-year apprenticeship program under the direct supervision of a licensed driller. The contractor must then successfully complete an examination that tests knowledge of drilling methods, well construction guidelines, basic geology and geohydrology, procedures for completing well log forms, and other important aspects of water well drilling.

Upon successful completion of the test, each contractor must post a $4,000 surety bond or its equivalent in cash. The bonding requirement is used as an enforcement mechanism--all or a portion of the bond may have to be forfeited to correct problems caused by failure on the part of the contractor to fulfill his responsibilities in conducting or overseeing water well drilling.

There are three concerns related to well drillers, their operations, and their licensing requirements. First, the legal distinction between water well contractors and drillers is confusing. This distinction is important because only water well contractors--not all drillers-- are legally required to obtain licenses from the board. Although the board encourages all drillers in the state to obtain a contractor's license, some don't. The result is that some drillers operating in the state lack a basic knowledge of proper well construction procedures, reporting procedures, and sampling methods. Development of licensing requirements for both drillers and contractors can help deal with this problem.

Second, the lack of both professional staff and field office facilities to assist the board in its duties is a concern. For example, the board has the power to set up training programs for drillers and contractors. It has been unable to institute needed training because it has only one half-time professional staff position, used primarily for investigation of drilling-related complaints. Fulfillment of this single responsibility alone is much more than can be handled state-wide with the current staff allowance. A complicating factor is that the board and its

half-time staff member operate only from Helena; they have no field base from which to carry out licensing, training and regulatory responsibilities state-wide. A field base could improve response to the needs of both the public and the water well drillers.

A final concern is the quality of the information submitted by water well drillers to comply with statutory reporting procedures. For example, state law (MCA 85-2-515) requires the driller to file a well log report with DNRC within 60 days after any well is completed. Most drillers comply with this requirement, but some fail to complete and return any well log to DNRC. Well logs that are submitted sometimes lack critical information on the location of the well or on the nature of the geologic units drilled. Proper completion of well logs is important because the logs provide a tremendous source of hydrogeologic data to the state and its citizens at relatively little expense. Requiring licenses of all drillers operating in the state and development of an effective continuing education program for drillers and contractors would help rectify this problem.

Council Recommendations

The Council recommends that the legal distinction between water well contractors and water well drillers be clarified. The definition of a contractor should focus on the financial responsibility assumed in contractual obligations for well drilling; the definition of a driller should focus on the operational responsibility in carrying out the act of drilling.

Licensing requirements should be changed to require licenses for both contractors and drillers. Like the present licensing requirement for contractors, a one-year apprenticeship and successful completion of the standard test should be mandatory for every driller operating in the state. Bonding to enforce well-drilling requirements established by the board should reflect the difference in legal and financial responsibilities between contractors and drillers. The bond requirement for drillers should be $4,000, the bond amount for contractors $10,000, and the bond should be payable to the injured party.

The Council requests that the board consider moving intact from the Department of Commerce to DNRC. The present structure of the Board will be retained. In addition to the transfer, the Council recommends that the staff of the board be increased to one full-time professional; secretarial duties associated with the board's activities could be handled by existing DNRC clerical staff.

Finally, the Council recommends that a continuing education program for well drillers be developed and implemented by the Board of Water Well Contractors.

Why the Council Adopted the Recommendations

The Board of Water Well Contractors has acted principally in a licensing capacity. The statutes under which the board operates and the staff resources available to the board must be strengthened so that it can effectively carry out the enforcement and training activities important in protecting both the public and the ground water resource.

Licensing of water well drillers is considered an important step in assuring that those who actually drill water wells are knowledgeable about proper procedures regarding well construction, completion and submittal of well logs and other aspects of vital importance in the protection and management of the ground water resource.

DNRC can support BWWC's work; DNRC has nine field offices established throughout the state that can be used by the board in the licensing, education, and regulation of the water well industry. In addition, DNRC also employs two geohydrologists who can provide some short-term technical assistance to the board and its staff in its regulatory and training duties.

BWWC staff should be expanded to include one full-time professional program manager. The existing part-time inspection position could be eliminated and its inspection functions instead accomplished with DNRC field office personnel. This overall increase in staff available to the BWWC would allow for the development and implementation of a training program for contractors and drillers state-wide.

What is Needed to Follow the Recommendations

Legislation will be needed to clarify the difference between water well contractors and water well drillers, extend the licensing requirements to all drillers and contractors, establish bonding requirements for each, and transfer the BWWC to DNRC. This legislation should be prepared by the Environmental Quality Council.

Transfer of BWWC and its responsibilities to DNRC and an expansion of the BWWC staff will cost $30,000 annually. This amount would cover the cost of one full-time program manager (Grade 13), as well as travel expenses for the board. The program manager would assist the BWWC by coordinating the enforcement and education program with Water Rights field offices and other staff, and researching training/regulatory standards that the board may wish to consider adopting.

WATER WELL CONSTRUCTION STANDARDS

Montanans face an ever-increasing problem of inefficient use and contamination of our ground water resources. In many instances, these problems are caused by poorly constructed wells.

Proper well construction refers to the installation and preparation of a well to maximize the efficiency and yield of the well and minimize the chances of aquifer contamination through leakage of contaminants along the casing or flow through the well itself. A generalized diagram of a properly constructed well is shown in Figure 7. Problems that can occur without proper well construction include

-- contamination of high-quality water from one aquifer by mixing with low-quality water from another aquifer where the well penetrates several aquifers and sealing of the casing is ineffective.

-- leakage of contaminants from the surface down along the casing and into the well, which occurs when surface sealing of the casing is inadequate and surface drainage toward the well occurs.

-- poor well yield and short well life where the driller fails to adequately flush fine-grained material from around the well screens or uses poor quality casing material.

-- inability to easily and inexpensively collect data on ground water levels at existing wells because of the lack of access ports.

Unlike other western states, Montana has not adopted any comprehensive, mandatory well construction standards. The Board of Water Well Contractors has adopted--under very general rule-making authority--minimum standards for water well construction and maintenance. These rules are by no means comprehensive. In addition, it is unlikely that the board has the authority to adopt and enforce more comprehensive standards. The Board of Health has also adopted some well construction standards, but they apply only to public water supply wells.

A document titled "Recommended Standards for Preparation of Water Well Construction Specifications" has been adopted by the Montana Water Well Drillers Association. This publication provides the water well construction industry with specifications for the construction of wells. These standards, though technically adequate, are not mandatory.

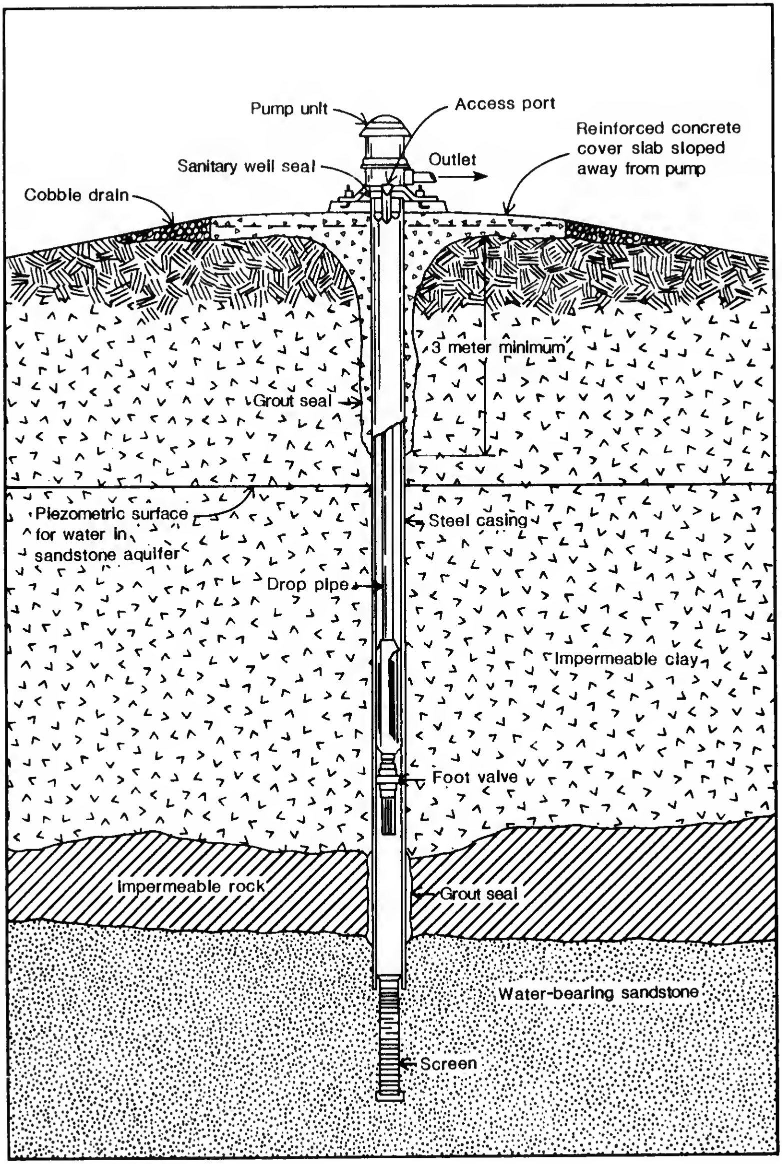


Figure 7. A drilled well showing grout seal, concrete slab, and well seal for sanitary purposes and port for access

Council Recommendations

The Council recommends that the Board of Water Well Contractors be given the statutory authority to adopt comprehensive well construction standards through the rule-making procedure. The Council also recommends that the board adopt mandatory well construction standards and enforcement procedures by July 1, 1986. The standards should be modeled after existing water well construction standards adopted by the Montana Water Well Drillers Association (1970) and the U.S. Environmental Protection Agency (1975). At a minimum, the mandatory standards should address:

-- protection of the drilling site
-- acceptable casing materials specifications
-- well screens-materials and installation
-- casing perforations
-- well development procedures
-- proper sealing and grouting
-- temporary capping
-- cleaning and disinfecting of wells
-- contract bonds
-- guarantees
-- contractor's and driller's qualifications
-- tests for yield and drawdown
-- reporting procedures and requirements for water quality, well logs, location of well, and information relating to local conditions
-- well filters
-- access ports
-- gravel packing
-- sampling methods
-- plumbness and alignment of hole and casing
-- well abandonment procedures

Why The Council Adopted the Recommendations

Proper construction of wells is important for efficient use of the ground water resource, and prevention of well/aquifer contamination. Adoption and enforcement of mandatory well construction standards would help reduce problems associated with inefficient well operation and aquifer contamination.

What is Needed to Follow the Recommendations

Legislation is needed to give the Board of Water Well Contractors the authority to adopt comprehensive well construction standards and enforcement procedures. This legislation will be prepared by EQC and DNRC.

The Council recommends hiring one full-time program manager as staff for the Board of Water Well Contractors and transfer of the board and its functions to DNRC (see recommendations under Water Well Driller Qualifications). The program manager would assist the Board of Water Well Contractors in adopting mandatory well construction standards using the board's existing rule-making authority.

WELL INTERFERENCE

Well interference occurs when pumping from one well directly decreases the yield of another well. When the cone of depression in the ground water surface caused by pumping from one well reaches an adjacent well, the static water level in the adjacent well is reduced (Figure 8). Lowering of the pump in the well may be necessary to compensate for this static water level reduction and to maintain a constant yield. In more severe cases, the owner of the adjacent well may be forced to drill a deeper well to maintain his yield.

Well interference problems can be the result of a variety of factors, including the pumping rates, pumping schedules, and pumped volumes for wells penetrating the same aquifer; the distance separating adjacent wells; the physical properties of the aquifer; the degree to which the wells penetrate the aquifer; and whether the wells are adequately constructed.

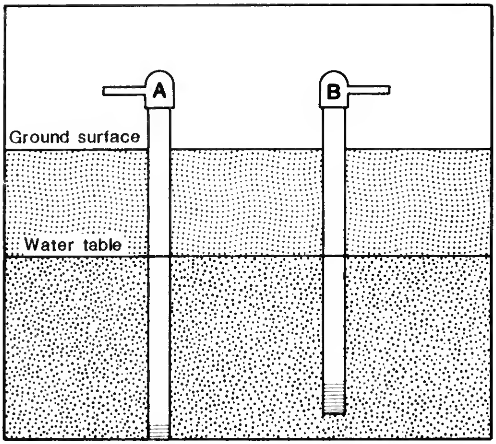
One option for dealing with well interference is the use of well-spacing requirements. The Board of Natural Resources and Conservation has the authority to form controlled ground water areas and institute within those areas well-spacing requirements and other measures to mitigate ground water use conflicts. If controlled ground water areas are used to implement well-spacing requirements, the degree to which they are used as a preventative--rather than reactive--measure will be important in determining their effectiveness.

Adequacy of well construction--including the degree to which wells penetrate the aquifer--is a major factor affecting well interference. Inadequate well penetration into an aquifer by a senior appropriator can prematurely limit the development of that aquifer. Any subsequent development that would reduce the static ground water level at the senior appropriator's well can be objected to on the basis that the new development would adversely affect a prior right. The anticipated interference problem, however, may be more attributable to insufficient aquifer penetration of the prior appropriator's well than to excessive rates of pumping by junior appropriators, inadequate well-spacing, or aquifer depletion.

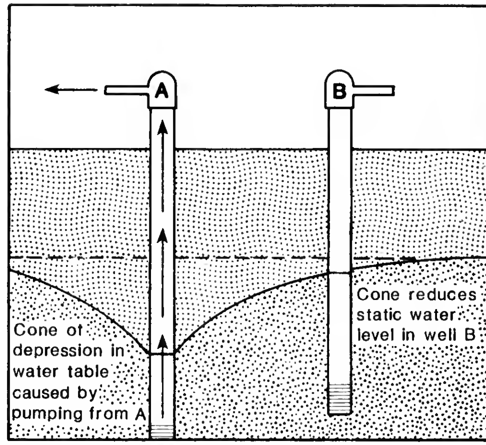
Council Recommendations

To promote the maximum reasonable level of aquifer development, DNRC--through its existing authority to administer permits for beneficial use of ground water--should ensure that the proposed means of diversion is adequate and that the aquifer penetration is sufficient.

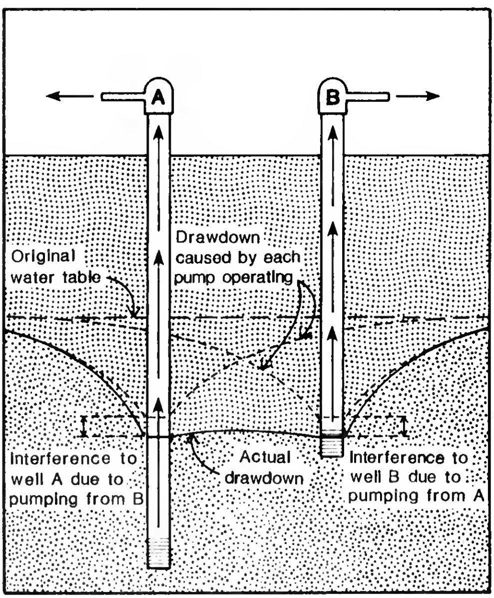
Area-wide well-interference problems should be addressed by using the existing authority of the Board of Natural Resources



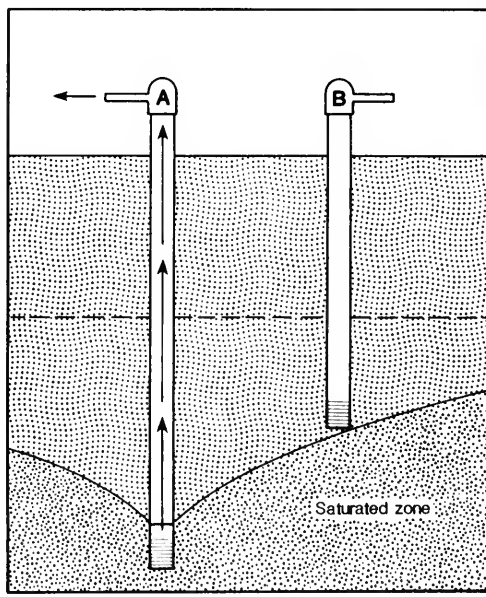
a) No pumping



b) Pumping from A only



c) Pumping from A reduces yield of B



d) Pumping from A stops yield from B
(Management problems due to partial penetration of well B)

Figure 8. Interference between pumping wells

and Conservation in forming and administering controlled ground water areas.

Why the Council Adopted the Recommendations

Inadequate well construction/aquifer penetration by senior appropriators can strongly affect whether development can occur without unreasonably affecting those senior appropriators. Adoption and enforcement of mandatory well construction standards have already been recommended, but adequate aquifer penetration is also important in optimizing aquifer development.

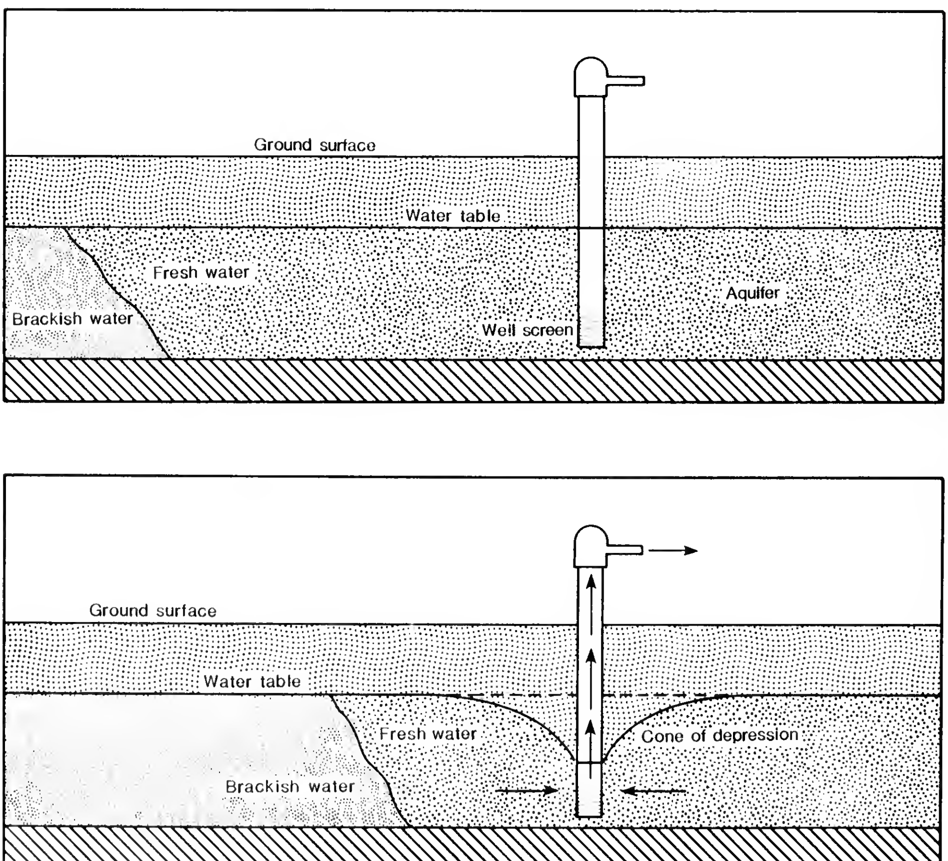
The Board of Natural Resources and Conservation's authority to address well-interference problems through the use of special regulatory measures within controlled ground water management areas is considered adequate.

What is Needed to Follow the Recommendations

No action is necessary.

Degradation of ground water quality can occur where pumping from one aquifer induces recharge, either vertically or laterally, from another portion of the same aquifer or another aquifer system that contains water of poorer quality (Figure 9). Ground water quality problems can also develop where pumping an aquifer with hydraulic connection to a poor-quality, surface-water body creates a cone of depression that intercepts the surface-water body, causing the polluted surface-water body to recharge the aquifer. If the stream carries a pollutant that is not removed by percolation through the aquifer, the contaminant will be drawn into the ground water system and subsequently withdrawn through wells tapping the aquifer.

Figure 9. How pumping can affect ground water quality



In both of the cases cited above, the quantity of ground water withdrawal can influence the quality of water within the aquifer. Faster rates and larger volumes of withdrawal often create more significant head differences between the area of pumping and the contaminant source, which in turn increase the rate of migration of the poor-quality water.

The relationship between ground water withdrawal and ground water quality is not currently recognized in Montana water statutes. Water quality statutes are directed at point- and nonpoint-source pollution caused by the addition of contaminants to ground water by humans. Yet in many cases, contaminants such as salts are already present because of natural processes and can be induced to migrate into an aquifer by ground water withdrawals. While state statutes deal with the problems of excessive ground water withdrawal and the effects of these withdrawals on the quantity of ground water available to other users, the law does not deal with the effects of withdrawals on the quality of the remaining available ground water.

Council Recommendations

The Council recommends that the language of statute MCA 85-2-506, giving authority to the Board of Natural Resources and Conservation to form controlled ground water areas, be changed to allow formation of such a management area in response to water quality degradation caused by excessive withdrawals and contaminant migration.

Why the Council Adopted the Recommendations

The existing statute governing the formation of controlled ground water areas does not currently recognize water quality problems associated with over-withdrawals as a justification for regulating those withdrawals through the formation of a controlled ground water area.

What is Needed to Follow the Recommendations

DNRC should prepare draft legislation to modify MCA 85-2-506 accordingly.

GROUND WATER DATA AND INFORMATION NEEDS

Subcommittee Members:
Marvin Miller, Chairman
Dorothy Eck
Dennis Nathe
John Scully

- A water well driller working with a land developer on a subdivision in the Gallatin valley needs well depth and aquifer yield information in order to proceed with his plans.

- A rural electric cooperative in Sheridan County wants to market ground water heat pumps as a heating alternative in its service area. It needs information on ground water yield, depth, dissolved solids, pH, and temperature.

- A farmer near Ryegate wants to develop irrigation on his farm using ground water from the Eagle Formation which underlies his land. He needs information on aquifer depth, yield, and water quality for his project.

- A state agency evaluating high nitrate concentrations in ground water at a Hutterite colony needs to know if the group has access to any alternative water sources that may have lower nitrate concentrations.

Most rural citizens, state government agencies, federal government agencies, consultants and engineers at one time or another have ground water problems to solve. To whom do these individuals, groups and agencies turn for help? In Montana, the MBMG, DNRC, DHES, DSL, University of Montana, Montana State University, U.S. Forest Service, U.S. Geological Survey, EPA and Montana Water Resources Research Center, among others, each may have some of the answers. Yet each group obtains and processes only partial sets of ground water data, often focusing on particular sites or problems. In addition, data collected by each agency are not necessarily collected or organized according to a standard format. For example, a well location identified only by a locally derived identifier (north well, south well, well T-3, etc.) rather than a regional identifier such as Township, Range and Section or Latitude-Longitude, is generally not very useful to those users who do not know the significance of the local identifier (and therefore the location of the data point).

Many discussions about issues outlined in the previous section of this report focus on the lack of knowledge or data about ground water. Much ground water data already collected in Montana are not accessible to potential users because of inadequate data management and organization. The fragmented nature of ground water data management in Montana can be corrected by centralizing ground water data management functions.

In order to provide better service to her citizens and to prevent loss of important ground water data, Montana needs to support a continuing, centralized Ground Water Information Center that will collect, manage, evaluate, and publish ground water data.

GWIC would be a centralized entity that would consist of a field program and an office program. The office program would be aimed at the development of standard sets of ground water data to be collected during well inventories, including ground water sampling, aquifer tests, and accurate water well logs. Reorganization of existing computer files to allow implementation of query systems and improved accessibility of data would also be of high priority. The correction and verification of data before entry into the data system is considered critical and would also be accomplished in this phase of the program. Other objectives would include the publication of basic data reports, including hydrogeologic maps, and maintenance of a library containing published and unpublished hydrogeologic reports on both paper and microform.

An effective GWIC cannot rely solely on water well logs and previously published data as its sources of information, however. Although these sources are important, they are inadequate because they often do not provide data in areas of new ground water development and the data that are provided are often incomplete. Consequently, an Information Center must be able to obtain new and scientifically controlled data from a field program.

The major tasks of the proposed field program would include

- maintaining, improving and expanding a statewide monitoring well program as needed;
- systematically collecting water quality samples from selected wells with emphasis on problem areas determined by DHES, DNRC, Montana State University Cooperative Extension Service, DSL, Montana Board of Oil and Gas Conservation and others;
- inventorying newly drilled wells in strategic areas to obtain water quality data, geophysical logs, and aquifer test data to serve as "Bench Mark Data" for correlation of local and regional hydrogeologic characteristics;
- inventorying existing water wells; and assisting local communities and state agencies in technical data-gathering problems (aquifer testing, well logging);
- instituting a systematic aquifer-testing program with specific emphasis on problem areas being evaluated by DNRC or other agencies.

The field effort could be managed as a State Service Program. For example, if DNRC needed observation wells and an aquifer test to deal with a critical water-rights problem, it could request that MBMG drill the necessary holes, conduct the test, and make a report. The agency would gain the information it needed to solve its problem, and Montana would, at the same time, gain valuable knowledge about its ground water resource. That knowledge would then become part of the central ground water data base.

One result of compiling ground water data is a state-wide data base from which a great variety of hydrologic questions can be answered. For example, the following questions could be answered quickly and efficiently: What data already exist for a project area? Is the water quality in my well or spring suitable for irrigation use? How deep do I need to drill to complete a well in my area and what can I expect for a yield? Often the data offered in response to this type of inquiry have more significance to the user when viewed in the context of wells or springs in similar situations. For example, determining whether or not a well is contaminated by sewage may depend on comparing the nitrate concentration in its water to the regional average nitrate concentration for that aquifer. If the background nitrate data exist in a central data system, the comparison can easily be made.

The most critical requirement for maintenance of the GWIC is a long-term, dependable source of funding. Clearly, the center fulfills a long-term need. To date, financial support for such a center from the state has been low. Work already accomplished in this effort has resulted from out-of-state funding. These funds were never adequate to support the necessary tasks and, more critically, are no longer available.

Possibilities for GWIC funding sources include the General Fund; the Resource Indemnity Trust Account; new fees on ground water users; and indirect cost recovery from all state- and federal-funded water projects in Montana. The Council strongly feels that the center is vital for Montana's future management of ground water, but difficulties still exist in determining how to fund the program. Whatever source is agreed upon, it is important that the program have long-term financial stability.

Council Recommendations

The Council recognizes the formation of the Ground Water Information Center within MBMG in Butte to function as a central repository for ground water data collected in Montana. The Council supports the grant applications submitted by MBMG through both the Water Development and proposed Legacy programs to secure funding for operation of the center during the next biennium. Finally, the Council recommends that the Legislature send to the Board of Regents and the governor a resolution requesting that the University System include, as part of its 1988-89 budget, sufficient funding to sustain the Ground Water Information Center.

Why the Council Adopted the Recommendations

The Council recognizes the necessity of proper management of ground water data. Both the field and office programs for the Information Center are needed. The office program would evaluate

the quality and reliability of existing and new data, and would incorporate both into the system. The program would assure that all data are organized for reference purposes and readily accessible for public use.

The field program would be geared toward collecting additional ground water data in areas where little or no data are presently available or where actual or potential ground water problems exist. The field program, coupled with strong interagency cooperation, would help Montana resolve ground water management problems and gain valuable knowledge about her ground water resources.

What is Needed to Follow the Recommendations

The field and office programs would require 6.25 full-time employee positions; 3.25 would be assigned to the office program and 3.0 to the field program. Operation costs would be substantial--the field work requires mileage and per diem charges to support the workers. Anticipated costs for the Information Center for the biennium are outlined below.

	Field	Office
Salaries	$165,287 (3.0 FTE)	$144,073 (3.25 FTE)
Operations	$192,730	$ 6,000
Capital	$ 39,000	-0-
	$397,017	$150,073
Total	$547,090 for the 1986-87 biennium	

The Council instructed MBMG to write a proposal for Water Development Program funds to finance part of the Ground Water Information Center from the Water Development account. The proposal submitted by MBMG requested funds to purchase computer hardware support for the Information Center and received the highest ranking out of 76 proposals submitted. MBMG is also applying for funds from the proposed Legacy Program to help finance the Information Center's staff and operations during the 1986-87 biennium.

GROUND WATER QUALITY MANAGEMENT

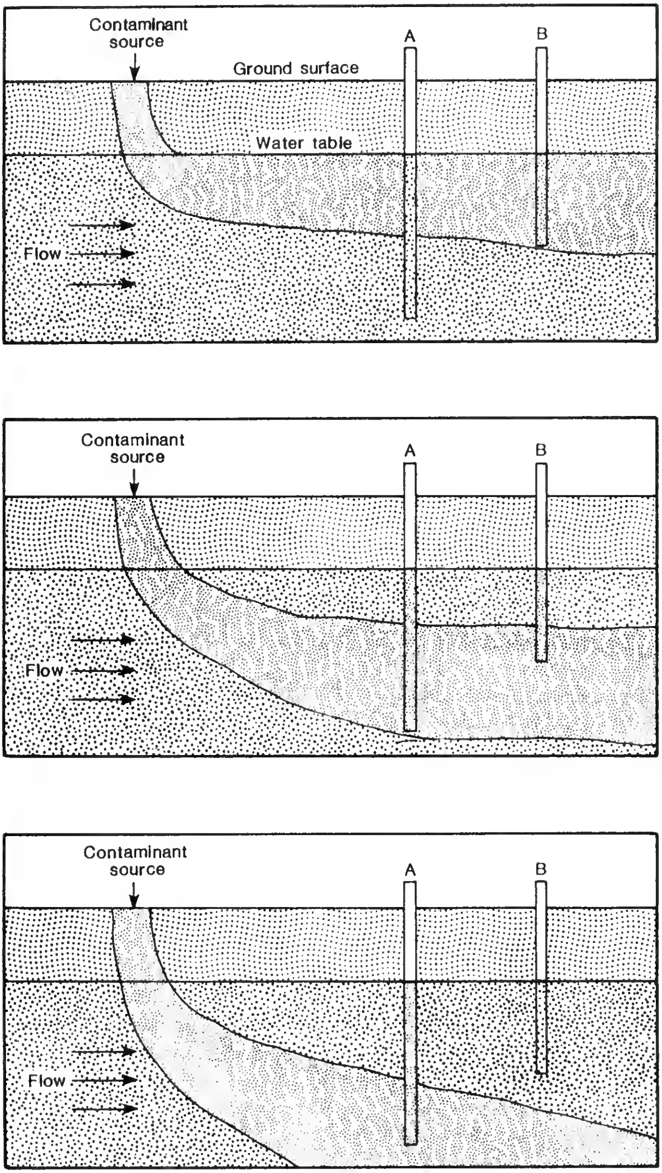
Subcommittee Members:
Fred Shewman, Chairman
Joe Moreland
John Duncan
John North
Dennis Iverson

In recent years, the nation has awakened to the threat of ground water contamination. This issue is widely accepted as the nation's number one environmental problem. Whereas surface-water contamination is generally easy to recognize and simple to address, ground water contamination is often difficult to detect or impossible to correct. Color, turbidity, fish kills, and other visual clues provide evidence of contamination in streams. If not readily apparent, surface water contamination can be detected from chemical analysis of collected samples. Once detected, the source of contamination can be investigated and mitigating measures can be developed. After the source has been treated or eliminated, quality usually recovers relatively rapidly. Such is not the case in ground water systems.

Wastes can percolate for years into an aquifer before contamination is detected in down-gradient wells. Many hazardous wastes will not mix with water and may float at the water table or sink to the base of the aquifer (Figure 10). Consequently, wells must be located at the proper site and perforated at the proper depth in order to detect contaminants in the aquifer. Even after contamination is verified, identifying the source can be difficult. If the source can be pinpointed and corrective measures are taken to halt the inflow, years of accumulated contaminants in the aquifer must be dealt with. Aquifer restoration, except in the most ideal situations, is expensive and often technologically unfeasible.

Threats to ground water quality are numerous. Dispersed sources of contamination include application of fertilizers, herbicides, and pesticides to croplands and lawns; improperly operating individual septic tanks (Figure 11); and airborne contaminants from industrial activities. Point sources of contamination include poorly located landfills (Figure 12), storage tanks for gasoline and other materials, mine tailings, stockpiles of ore or industrial chemicals, and waste disposal lagoons. Tons of potentially dangerous substances are perched precariously above drinking water supplies atop thin layers of compacted clay, supported by membranes of plastic film, or contained in rapidly corroding metal tanks. Although Montana does not face the extreme health hazards posed by the exotic chemicals found in more industrialized states, citizens should be aware that even rural communities use fuel oils, pesticides, cleaning solvents, chemical preservatives, and numerous other potentially toxic substances. Many of these chemicals have been recognized as contaminants in Montana aquifers.

In most rural areas, ground water is usually the sole source of water for domestic needs. Providing an alternative supply of water to replace degraded aquifers would be an expensive undertaking. Miles of pipeline would be required to connect farmsteads to a community supply, assuming an alternative source



a)

The contaminant is slightly more dense than ground water. The contaminant is detected in Well B but not Well A.

b)

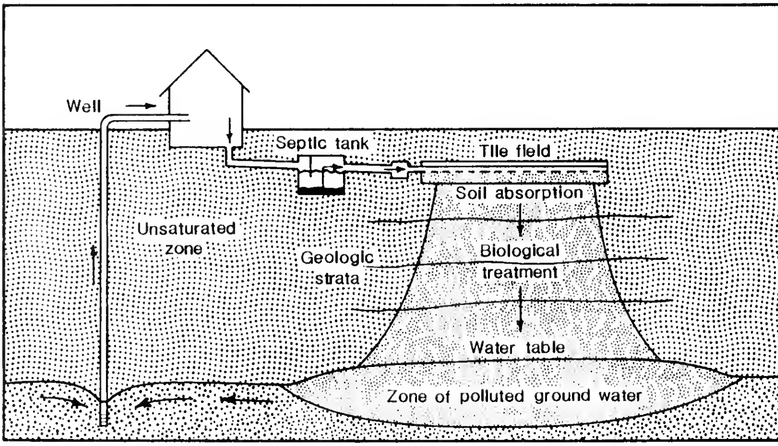
The density contrast is larger. The contaminant is detected in both Well A and Well B.

c)

The contaminant is much more dense than ground water. The contaminant is detected in Well A only.

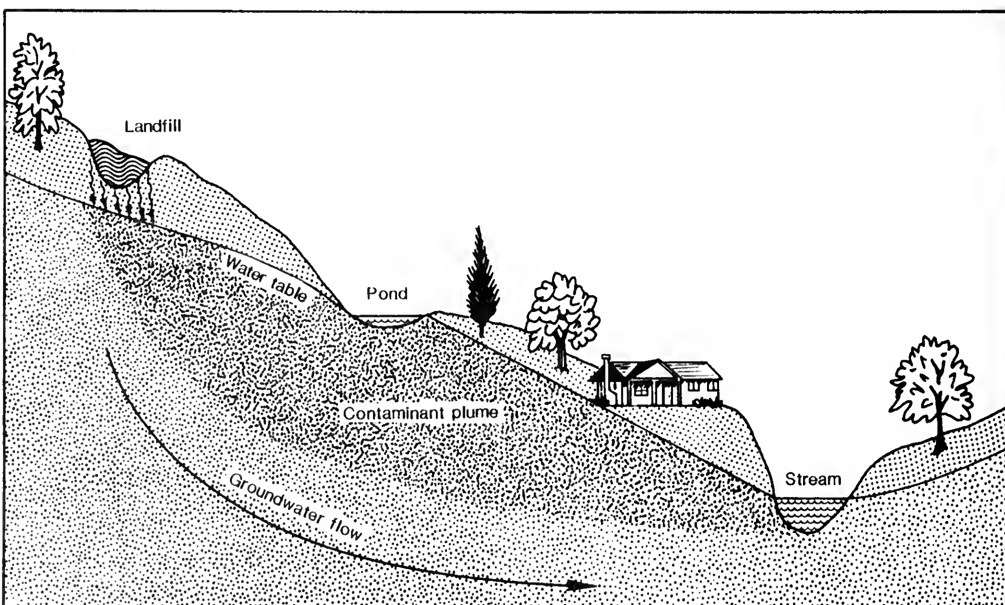
Figure 10. Contaminant behavior in a ground water system and the importance of proper observation well penetration

Figure 11. Ground water contamination from improperly functioning septic systems



From : Ground Water Issues and Answers, American Institute of Professional Geologists, 1983.

Figure 12. Ground water contamination from a poorly located landfill



From : Ground Water Issues and Answers, American Institute of Professional Geologists, 1983.

could be found. Even in more densely populated suburban/rural communities, the cost of retrofitting central distribution systems could be enormous. It is in the state's best interest to carefully guard against loss of this relatively inexpensive source of drinking water.

The recently adopted Montana Ground Water Pollution Control System, the Environmental Protection Agency's (EPA) Underground Injection Control Program, the EPA's Ground Water Protection Strategy, and other state and federal rules and regulations are designed to minimize the threat of ground water contamination. However, none is designed to inventory current ground water quality conditions or identify past activities that may have impaired ground water quality. Those rules or regulations that provide for ground water quality monitoring are site-specific and are intended primarily to document the effectiveness of specific projects. No comprehensive state-wide monitoring program is in operation to establish baseline data to which future ground water quality can be compared to detect long-term changes in ground water quality.

Although funding a state-wide monitoring program is always of concern, there are ways to reduce the state's share of program cost. The U.S. Geological Survey State/Federal Cooperative Program is set up to provide a cost-sharing mechanism between federal and nonfederal parties in the collection of ground water and surface water data. Under this program, the nonfederal party must commit up-front funding to the monitoring effort which--through a contractual agreement--could be matched by the federal government on a dollar-for-dollar basis. Thus, if Montana needs $200,000 to install an observation well network and collect data from that network, the monitoring program could be eligible for matching funds from the federal government and thereby reduce the state's share of program costs to $100,000. Federal matching funds are awarded based on local and federal interest, availability of nonfederal, cost-sharing funds, scientific merit, and other factors.

Council Recommendations

The Council recommends that the Montana Bureau of Mines and Geology, working with the Department of Health and Environmental Sciences, conduct an appraisal of ground water quality conditions in major aquifer systems throughout the state. The bureau should complete its assessment within the next six years. The suburban areas surrounding major cities where ground water occurs in highly permeable, unconsolidated, alluvial deposits should be given high priority. Areas surrounding Billings, Missoula, Helena, Bozeman, and Kalispell are prime examples of areas susceptible to ground water contamination. Many of these areas have been the subject of recent intensive surveys and review of available data may be sufficient to document current ground water quality. Where studies have not been conducted, intensive ground

water sampling efforts may be required. These sampling efforts should fully use federal cost-sharing funds available through the USGS Cooperative Program.

MBMG should also develop a long-term monitoring program to establish baseline ground water quality information state-wide. This effort should use federal funds that may be available through the USGS Cooperative Program.

Why the Council Adopted the Recommendations

Because people depend on ground water supplies to provide for many domestic, stock, irrigation, municipal and other needs, they have a high stake in detecting changes in ground water quality that would affect those uses. The spread of contaminated ground water in neighboring states should provide ample encouragement to Montana to guard against pollution. The site-specific approach of focusing monitoring efforts around suspected point sources of pollution should be emphasized because of its cost-effectiveness. A more comprehensive, state-wide ground water quality monitoring system would also be needed to establish baseline water quality information for ground water supplies which could be affected by more dispersed sources of ground water contamination.

What is Needed to Follow the Recommendations

MBMG will submit funding requests--either directly to the legislature or to the appropriate grant programs--as needed over the next three bienniums to prepare the water quality assessment and expand the state-wide ground water quality monitoring program.

SPILLS AND UNDERGROUND SYSTEM LEAKS

Significant sources of ground water contamination in Montana include surface spills of pollutants, pipeline leaks, and underground storage tank and delivery system leaks. In the 21 months ending August, 1984, 38 instances of ground water contamination from these sources have been reported (Thompson, 1984). Most of these instances involve petroleum fuels; however, other liquid chemicals are also of concern. Because the number of known ground water contamination incidences is increasing, it appears likely that many more unknown instances of ground water contamination are occurring throughout Montana.

As of 1980, liquid pipeline mileage in Montana exceeded 8,000 miles, and was transporting more than 300,000 barrels of crude and refined products per day. There are an estimated 3,000 to 4,000 steel gasoline tanks buried at gas stations, and an associated 20 to 25 miles of underground pipeline that connect the tanks to the gasoline pumps. Approximately 726 bulk plants exist in the state, each having various storage tanks of 150 to 100,000 gallons. Other potential sources of contamination are fuel tanks for public and private buildings, oil field operations, and truck and rail transportation accidents.

The most obvious need for remedying a ground water contamination problem occurs when the ground water serves as a source of drinking water. In Montana, however, there is a statutory directive establishing a nondegradation policy for any ground water where existing quality is higher than the established water quality standards. Thus, regardless of the use given such water, state authorities have a duty to prevent its further contamination.

The Department of Health and Environmental Sciences administers the state ground water quality programs. Yet, it is limited in its ability to deal with this ground water contamination problem. The department's present statutory authority emphasizes remedial actions to reduce or minimize existing contamination; these actions, however are after-the-fact and are restrained by limited funding and the extremely high costs of ground water investigations. Currently, no regulations are directed toward prevention of contaminant spills and underground system leaks. This aspect of the problem could be addressed by a tank inventory along with regular monitoring and tightness testing requirements.

Although the department does have authority to issue cleanup orders, actions must often be taken before the responsible party can be identified. Notwithstanding staff time, the costs of drilling holes or using a backhoe simply to determine the degree of ground water contamination can rapidly reach hundreds, and perhaps thousands, of dollars. In addition, identifying the responsible party is costly and time consuming due to the

complexities of determining geologic structure and ground water movement, the potential for multiple sources of contamination, and the time lag before detection of the leak. While DHES may be able to recover the costs of its efforts for the state and assess penalties through court action, the cost of determining liability may approach $25,000 or more. Cleanup would cause the department's expenditures to far exceed these levels--sometimes by hundreds of thousands of dollars. Even so, initial removal of petroleum products is normally only about 70 percent effective because contaminants cling to soil and rock particles.

DHES's ability to handle ground water contamination problems is also limited by its inability to spend recovered money. Thus, up-front funding and a recycling of funds are both options that would help DHES more adequately fulfill its delegated responsibilities.

The petroleum leakage/spillage problem is prevalent in many states. State actions on this problem, however, are generally in the formative stages. Florida is one state that has passed comprehensive ground water legislation to address this problem (Thompson, 1984). In responding directly to the problem of ground water contamination caused by above- and below-ground storage tanks, three types of regulations were set up. First, a storage tank inventory system was established that requires owners of existing facilities and new facilities to register with the Department of Environmental Regulation, and to additionally notify the department regarding any changes in the status of their tanks.

Second, the regulations include preventative measures to protect against leaks or spills from tanks. These measures include provisions for minimizing overfills, treating abandoned tanks, and installing leak detection devices. For existing storage tanks, the regulations require retrofitting according to a schedule based on the age of the tanks.

Third, the regulations contain standards for handling or repairing storage tanks once leaks are detected.

The state of Florida requires insurance or bonding to indemnify losses caused by contaminated ground water and has set up a Water Quality Assurance Trust Fund. The trust fund is available to assist the department in cleaning up contaminated areas and to pay for costs when the owner cannot be identified or decides to contest liability. The cap on the fund is $12 million.

Council Recommendations

The Council supports

-- the development of an inventory system to identify abandoned storage tanks, existing storage tanks in use, and new storage tanks as they are installed.

-- the implementation of a system requiring preventative measures and monitoring for leaks for both newly installed and existing storage tanks and pipelines.

-- the creation of a fund to support adequate cleanup of accidental spills and leaks and to identify the responsible party or parties.

The Environmental Quality Council and the Department of Health and Environmental Sciences are investigating programs that would encompass the above components and develop implementation needs.

Why the Council Adopted the Recommendations

An alarming increase in the number of reported instances of ground water contamination associated with spills and leakage of underground pipes and storage tanks indicates a growing problem. The difficulty of restoring an aquifer once contamination occurs and the problem of timely contaminant detection require aggressive action in prevention and containment of spills from these sources.

What is Needed to Follow the Recommendations

Cleanup fund legislation and a Legacy program funding proposal will be presented for consideration by the 1985 Legislature.

GROUND WATER CONTAMINATION FROM RESERVE PITS

Reserve pits used in oil and gas drilling are potential sources of ground water contamination. In the Williston Basin of eastern Montana--where most oil and gas drilling takes place in the state--surface layers are drilled using fresh water. After the surface casing is set, fresh water is either replaced with produced brines or salt is added. These brines or saline drilling fluids may contain 100,000 to 200,000 ppm (parts per million--a measure of the concentration of a given substance) of salt, primarily sodium chloride. Clays, gels, bentonite, starches, and a variety of chemicals are added to drilling fluids to complete the hole.

These fluids, called drilling muds, lubricate the drill bit, carry cuttings to the surface, and provide pressure to maintain the sides of the borehole and control formation pressures. They flow through the circulating system as shown in Figure 13, down the center of the drill pipe, through the drill bit, back up the annulus (space between the drill pipe and the borehole), and into the mud tanks to be recycled through the system.

The mud tanks are periodically cleaned and accumulated silts and sludge washed into a reserve pit. This pit, usually lined with plastic, is dug adjacent to the drilling rig to hold drill cuttings screened from the mud return lines, wastes associated with rig operations, and the drilling muds and sludge cleaned from the mud tanks (Figure 13). Reserve pits vary in size, but are usually 60 to 70 feet wide, 150 to 200 feet long and 8 to 12 feet deep.

After completion of the well, the reserve pit is filled and the drill site reclaimed. Contractors generally follow one of two procedures for disposal of pit materials--off-site disposal or burial at the site. Off-site disposal involves emptying all of the pit muds and fluids and transporting them to an alternate disposal site, such as another reserve pit or landfill. This procedure is followed if it is stipulated before drilling begins that no wastes are to be buried on the site.

The usual method of disposal is to bury pit materials at the drill site. This process involves pumping out the less viscous portion of the pit contents for disposal into an injection well. Next, bulldozers "squeeze in" the pit to concentrate the remaining wastes. Trenches are dug out from this condensed pit, and the muds pushed in and buried. The pit liner is either buried with the muds or removed from the site. The American Petroleum Institute recognizes this squeezing and trenching process as an acceptable method of drilling fluid disposal and recommends that pit liners be disposed of properly before backfilling the site and restoring to original contour.

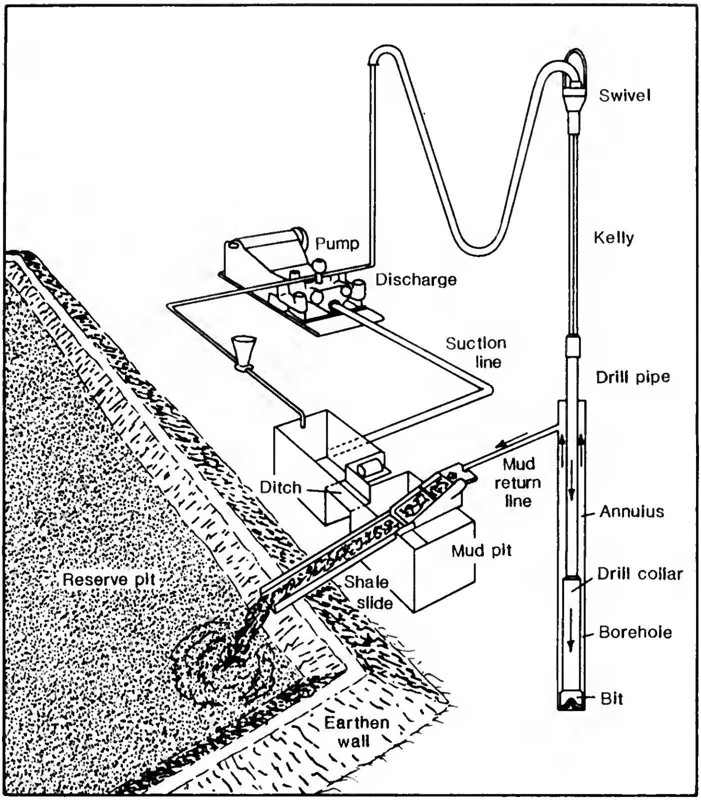


Figure 13. Reserve pit and drilling mud circulation system

These pit fluids may have a very high content of salt, especially chloride. An analysis of a Richland County pit sample showed a chloride concentration of 38,300 parts per million (ppm). For comparison, sea water contains about 19,000 ppm chloride, and the drinking water standard for chloride is 250 ppm.

The problem with the conventional reserve pit reclamation method is that pit liners are torn or removed during the process. No liner remains to prevent the material in the trenches from leaching into the soil or ground water. Thus, these reserve pits are potential sources of ground water contamination. Significant plumes of salinity have been documented under some of these reclaimed sites (Dewey, 1982).

Another problem is the common practice of spreading reserve pit fluids and produced brines on county roadways for dust control. The continual addition of these solutions to roadways may result in a buildup of salts in area soils and eventually an increased salt load in the ground water system.

The regulation of oil and gas exploration, development, and production in Montana is the responsibility of the Board of Oil and Gas Conservation (Title 82, Ch. 2 and 11, MCA) and is administered by DNRC's Oil and Gas Conservation Division. The purposes of the regulations include: (1) prevention of waste in oil and gas exploration and production; (2) reclamation of disturbed lands; and (3) prevention of water pollution problems related to oil and gas activities.

These regulations require that the drilling operator construct a reserve pit in a manner adequate to prevent undue harm to the soil or natural water in the area. When a salt-base mud system is used as a drilling fluid, the pit must be sealed when necessary to prevent seepage. All solid waste that accumulates must be contained and disposed, and must either be removed from the well site or buried to a minimum depth of three feet below the restored surface of the land.

Council Recommendations

The Council recommends that the Board of Oil and Gas Conservation assess the extent to which presently accepted reserve pit reclamation procedures threaten ground water quality.

Why the Council Adopted the Recommendations

Monitoring ground water conditions near reserve pits is not mandatory and is infrequent. Thus, the true extent of ground water pollution associated with operation and reclamation of these pits is not known. The documented instances of ground water contamination associated with reserve pits that have been monitored together with the large number of exploration and development wells drilled indicates that the number of reported contamination incidents may be small in comparison to actual contamination occurrences. The state should take steps to assess the extent of ground water contamination caused by reserve pits.

What is Needed to Follow the Recommendations

The Council will send a letter to the Board of Oil and Gas Conservation requesting the assessment.

SALINE SEEP CONTROL

Saline seep is a saline water discharge at or near the soil surface down-slope from a recharge area (Figure 14). It reduces or eliminates crop growth in the affected area because of increased soluble salt concentration in the root zone.

The leading cause of saline seep is the practice of the crop-fallow system of dryland farming. Many soils do not have sufficient water-holding capacity to retain all of the precipitation and snowmelt received during the fallow period. As a result, much of the water either runs off the field or percolates below the root zone. Deep-percolating water in the recharge area dissolves soluble salts and causes a gradual rise in the local water table. If the rising water table surfaces, a saline seep is formed.

Among the most important of the state s resource problems, saline seep has taken over 280,000 acres of cropland out of production (Miller, et al 1978). Saline seep damage is growing at a 10 percent yearly rate (Miller, 1971; Bahls and Miller, 1973; Miller, et al 1978).

Degradation of surface and ground water is not easily quantified but is perhaps the most severe consequence of saline seep. The water quality in most seeps greatly exceeds the recommended limits for irrigation, domestic, or stock use. Seep water commonly contains ground water of more than 25,000 ppm of total dissolved solids and has exceeded 78,000 ppm. For comparison sea water averages about 36,000 ppm of total dissolved solids.

Saline seep most often affects the shallow ground water system, which is also likely to be the primary source of potable water in the region. Installation of rural water lines is then needed to replace the local ground water supply. In addition, wells supplying water for irrigation must sometimes be abandoned because of salinity, and surface water supplies fed by saline ground water may no longer be usable.

The best solution to the problem is to use precipitation where it falls, before it moves beneath the root zone. Three of the most successful control practices to accomplish this solution are: (1) growing deep-rooted perennial crops, such as alfalfa in recharge areas; (2) switching to flexible intensive cropping systems; and (3) draining selected upland freshwater potholes that are sources of recharge to the ground water system.

Through cooperation and coordination among researchers, farmers, and agencies, the origin and development of saline seep have been evaluated. Effective saline seep control strategies have been developed and applied to small research sites to demonstrate that the problem could be controlled by using the practices mentioned above.

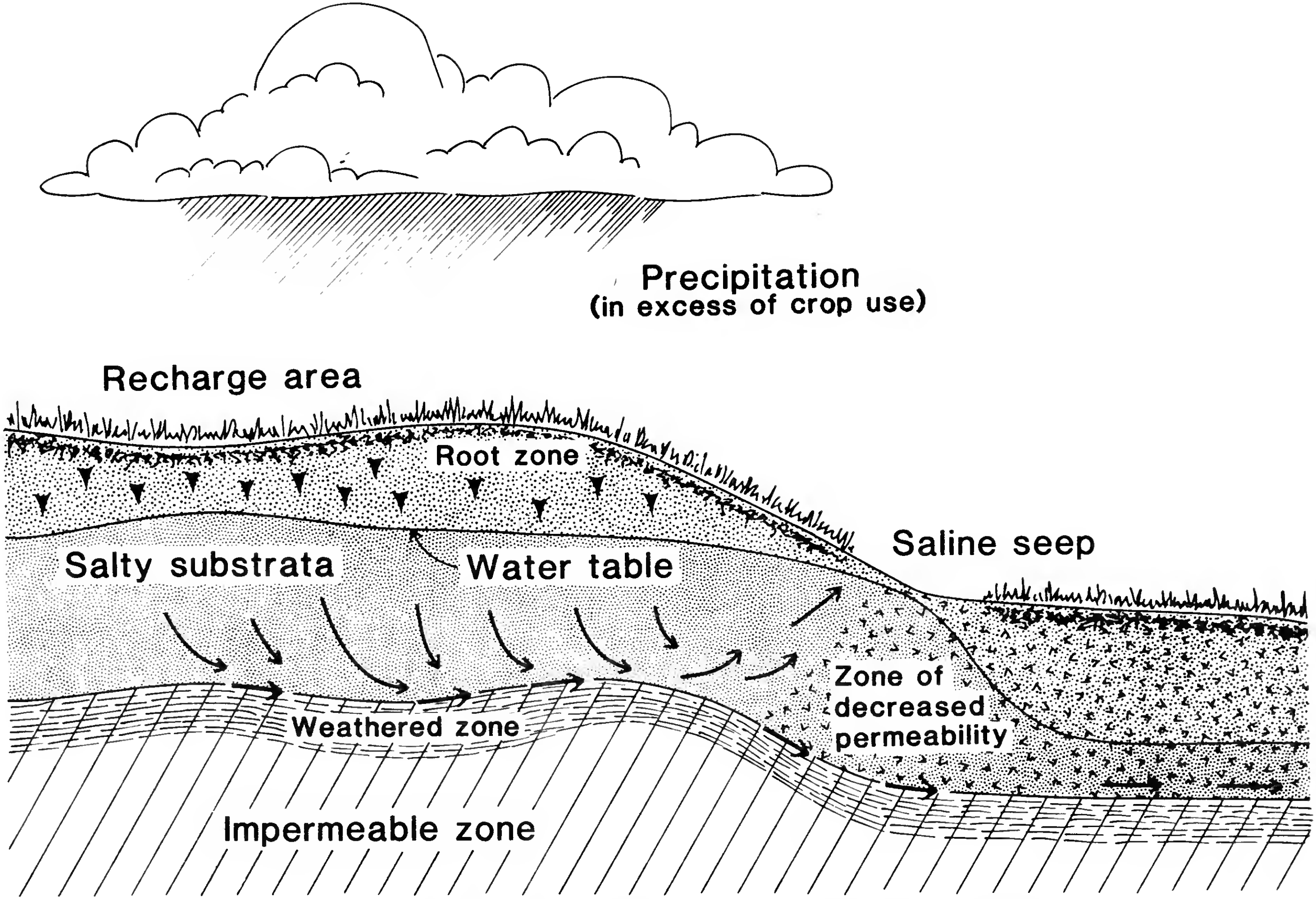


Figure 14. Schematic diagram illustrating the typical formation of saline seep.

Just as important has been the recognition that the causes and effects of saline seep extend across property and political boundaries. Thus, only a control effort based on cooperative, regional management is effective.

In support of a regional approach to manage saline seep, the 1979 Legislature approved a funding grant through the Renewable Resource Development Program to create the Triangle Conservation District (TCD), a cooperative venture between nine county conservation districts in north central Montana. The TCD provides technical assistance to farmers in designing and implementing saline seep control practices throughout the area. In the five years TCD has been working on the problem, 216 individual farm plans to reclaim 6,810 acres damaged by saline seep have been implemented.

TCD's approach to saline seep control has been successful. Therefore, it will attempt to expand from nine counties to 33 counties during the next two years. This expansion will include areas in the Upper Yellowstone Basin and northeast Montana, where saline seeps are of growing concern.

The major problem with the saline seep control program in Montana is the lack of a stable funding source to finance the technical activities of the participating conservation districts. The TCD has relied heavily on quarterly or biennial grants from the Conservation Districts Earmarked Development Account ("223" money), the Renewable Resources Development Account, and the Water Development Program--along with local funds--to maintain its technical assistance operations. The availability of state funds to support the program often fluctuates yearly because of the guidelines governing the award of those funds, variability of money available, and the competition for funds. For example, no project can be funded more than twice through the Renewable Resources Development Program and TCD has already received funding grants from the 1979 and 1981 legislatures.

As a result of this instability in funding, keeping qualified staff in TCD is often difficult and program continuity is hard to maintain. When state funding shortfalls occur, the TCD must devote proportionately more of its technical staff resources to hustling for other funds and gaining additional money by engaging in technical investigations through contract work that may not contribute directly to the saline seep control effort.

Council Recommendations

The state should consider stabilizing its funding contribution to the TCD by including the state funding contribution as a line item in DNRC's Conservation Districts Division budget.

Why the Council Adopted the Recommendations

The locally-based, multi-county approach exhibited by the Triangle Conservation District has been highly successful in restoring the productivity of agricultural land damaged by saline seep. There is a need to continue the productive local-state funding partnership in maintaining and expanding this program in areas of need.

What is Needed to Follow the Recommendations

A budget to fund an expanded Triangle Conservation District will be submitted by DNRC's Conservation Districts Division.

Contamination of ground water caused by the improper disposal of hazardous waste is of utmost concern in the protection of human health. In 1983, over 11,300 tons of hazardous waste were produced in the state by the regulated hazardous waste community.

Hazardous waste generators can be characterized by the type of manufacturing process. The amounts of waste generated in Montana by the three major groups are presented in Table 1.

Table 1. Waste Generator Types and Quantity for 1983 (IT Corporation, 1984).

Generator Types		Amount
Petroleum Refining	(3 Companies)	5,000 Tons
Pesticide Formulators	(4 Companies)	5,700 Tons
Others	(22 Companies)	600 Tons

In addition, 64 other registered generators did not produce significant quantities of hazardous waste in 1983.

The total hazardous waste volumes generated in Montana consist of two components: a baseload volume and a one-time cleanup volume. The baseload volume is the result of routine operations. Normally, if the rate of production stays constant, the amount of waste also remains the same.

The one-time cleanup volume is generally related to disposal of hazardous waste contaminated soils caused by spills or rehabilitation of inadequate disposal facilities. The yearly volumes of these wastes are highly variable. Table 2 summarizes the baseload and one-time cleanup volumes for 1983 by type of waste generator.

Table 2. Baseload and One-time Cleanup Volumes for 1983 (IT Corporation, 1984).

Generator Type	Baseload Volumes	One-time Cleanup Volumes
Petroleum Refining	4,400	600
Pesticide Formulators	4,700	1,000
Others	300	300
TOTALS	9,400 Tons	1,900 Tons

Currently, most baseload generators in Montana treat and dispose of hazardous waste generated by their own facilities. In 1983, only 300 tons of the baseload volume were disposed of off-site. This waste consisted predominantly of organic liquids and sludges that were handled in drums or in bulk.

Most disposal of one-time clean-up volume takes place outside the state, usually at facilities located in Idaho, Oregon or Utah. This is because Montana has no commercial hazardous waste disposal facility. Approximately 1900 tons of one-time cleanup volume were disposed of in 1983; most consisted of soil contaminated with hazardous waste and was typically handled in bulk. The generation, transportation, treatment, storage and disposal of hazardous wastes in Montana are regulated under the Montana Hazardous Waste Act. The Act permits DHES to adopt rules governing the handling of hazardous wastes including standards for generators and transporters of hazardous waste and hazardous waste treatment, storage, and disposal facilities. Because the state program administered under the Montana Hazardous Waste Act is at least as rigorous as the Federal Resource Conservation and Recovery Act (RCRA) designed for the same purpose, the Solid Waste Management Bureau (SWMB) of DHES was granted authorization by the federal government in July 1984 to manage the hazardous waste program in Montana consistent with federal guidelines. The major function of the program is to issue permits to facilities that treat, store, or dispose of hazardous waste on-site and to provide technical assistance to hazardous-waste generators in the proper disposal or treatment of these wastes. Much of this assistance is directed toward helping Montana generators dispose of wastes at out-of-state facilities.

Federal and state waste regulations distinguish between generators producing 1000 kilograms (kg) or more of hazardous waste per month and those that produce less. Those that produce over 1000 kg per month are subject to heavy restrictions on transport and disposal of their hazardous wastes. Generators of less than 1000 kg per month are only lightly regulated.

Montana is concerned with several issues regarding the proper disposal of hazardous wastes. First, the continued feasibility of disposal of Montana's hazardous wastes at out-of-state facilities is questionable. The number of licensed disposal facilities near Montana is limited. The cost of transporting these wastes is rising and fees charged for the disposal of hazardous wastes at out-of-state facilities have escalated. Increasingly rigorous requirements for laboratory analysis of wastes and record-keeping have increased. These costs have hit smaller hazardous-waste generators particularly hard. In addition, the Northwest Interstate Compact on Low-level Radioactive Waste Management allows a state to limit, under certain conditions, the nature and type of hazardous waste accepted at facilities within its borders. Thus, Montana may not always be able to depend on out-of-state disposal sites as a means of hazardous waste disposal for individual generators.

Second, hazardous-waste generators that do not produce a sufficient volume of waste to be intensely regulated under either state or federal law are still required to dispose of those wastes in state-licensed sanitary landfills. Most of the landfills in the state, however, are not engineered or operated to handle hazardous wastes without contaminating ground water. In addition, almost all sanitary landfills in Montana are owned and operated by local governments. Many local government officials are expressing a growing concern over the liability they incur by accepting such wastes. About 20 percent of the local governments operating landfills no longer accept hazardous wastes. For some generators, this action substantially increases the cost of proper disposal. Dumping in unapproved sites becomes a greater temptation.

Third, the U.S. Congress recently passed legislation to reduce the weight exemption limit for hazardous-waste generators subject to stringent regulation under RCRA. The weight limit was reduced from 1000 kg per month to 100 kg per month. The effect of this reduction is twofold: the volume of hazardous waste subject to full regulation under RCRA will increase by at least 300 tons annually, and the number of generators subject to regulation under both state and federal programs could increase by ten times from approximately 93 to over 900. Numerous smaller businesses, industries, and agricultural operations will come under regulation. Many of these generators will be ill-equipped to deal with the increased paperwork required for tracking and analyzing wastes, as well as transportation and disposal costs. Greater burdens will be placed on local governments responsible for the maintenance and operation of sanitary landfills as these sites become the prime candidates for disposal of small volumes of hazardous waste. Because of liability, SWMB feels that many local governments will refuse even these small quantities of hazardous waste. Finally, the increase in the number of hazardous-waste generators subject to regulation by SWMB will increase the administrative work load of the Bureau dramatically.

One final issue bears on the problems of cleaning up spills and disposal of contaminated soils. The cost of spill cleanup is variable but often expensive because of the need for rapid mobilization of equipment and manpower, cleanup supervision, numerous inspections, sampling activities, and removal/transport/disposal of large quantities of contaminated soil. Cleanup costs for three accidental spills that occurred during May and April of 1984 ranged from $1,100 to $1.5 million. Because most spills are accidents, it is impossible to determine with any degree of accuracy the number that will occur over a given period of time. For example, there has been a three-fold increase in emergency cleanups of hazardous waste between 1983 and 1984. Because of this variability, budgeting for the state share of these cleanup costs is extremely difficult.

Council Recommendations

The Ground Water Advisory Council supports an evaluation of the need for--and feasibility of--developing a commercial hazardous waste collection, transport, and/or disposal system within the state to provide a more cost-effective alternative for proper handling of toxic and hazardous wastes generated in Montana.

Why the Council Adopted the Recommendations

Improper storage, transportation, and disposal of hazardous wastes poses a threat to human health and the environment. Inappropriate handling of hazardous wastes often causes ground water contamination. Removal of these contaminants from the ground water is extremely expensive and is not always effective. Disposal options available to hazardous waste generators in Montana are, at best, limited and generally expensive. The state should provide greater incentive for hazardous waste generators to pursue proper handling of wastes by combining existing regulatory programs with measures that decrease the cost and logistical complexities of proper waste handling.

What is Needed to Follow the Recommendations

The Solid Waste Management Bureau of DHES, along with the Environmental Quality Council, will present to the 1985 Legislature recommendations on establishing a commercial hazardous waste collection and transport system in Montana. Legislation and Legacy program funding proposals will be submitted to support the recommendation.

INTERAGENCY COORDINATION

Subcommittee Members:
Dennis Hemmer, Chairman
Gay Holliday
William Woessner

INTERAGENCY COORDINATION

The management of ground water is a complex business. It involves conducting basic research to determine the availability and behavior of ground water in a hydrologic system, the regulation of drillers whose business it is to secure ample ground water supplies for thirsty users, the siting of waste disposal sites so that ground water pollution is avoided, and the control of withdrawals so that new uses of ground water by one party do not preclude uses already established by other parties. It is understandable then that numerous agencies--each with different expertise and jurisdictions--would touch on ground water management and that coordination between these agencies could become a problem.

Three types of groups work with ground water on a professional basis. First are the federal agencies--notably the U.S. Geological Survey (USGS) and the Environmental Protection Agency (EPA). Their missions vary. USGS carries out baseline and project-specific research as requested by other federal agencies as well as state and local agencies. EPA is often the agency that carries out Congressional directives aimed at setting up new ground water regulatory programs to address serious problems Congress considers national in scope. EPA encourages state implementation of the program but often requires--as a prerequisite to state administration--that the state set up its own program along guidelines at least as stringent as EPA's.

The second group is the universities. Perhaps their most important role in ground water management is education. They also conduct research to identify the scientific basis of a problem and provide technical and/or institutional alternatives for its resolution. A considerable amount of site-specific data is often gathered during these activities.

The third group is the state agencies. They are usually the implementing agencies for both state and eventually federal ground water programs. Their roles are diverse. For example, DHES administers programs that protect ground water quality, the Board of Water Well Contractors regulates water well drilling in the state, DNRC administers water rights programs through which ground water withdrawals are regulated, and MBMG conducts research to define general ground water resources of the state as well as to address site-specific ground water problems.

In one way or another, all of these groups are involved in the acquisition and/or use of data on ground water. The issue of interagency coordination rests to a large extent with this activity.

No formal mechanism exists to assure that data-gathering efforts will address the highest priority needs among state ground water management agencies, nor are investigations

necessarily carried out to maximize the amount of information needed by other agencies having an interest in the study area. An interagency coordinating group could help resolve both problems. The group could act as an oversight committee in evaluating study proposals by the various agencies, then ranking those proposals according to overall benefits to the state. The guide would be of use to both the legislature and loan-and-grant agencies in awarding funds to support those data-gathering efforts. Because the coordinating group would necessarily be aware of which studies were being proposed, it could also help bring together different agencies with similar data-gathering interests in a specific area.

The Advisory Council for the Water Resources Research Center in Bozeman could be used to coordinate ground water study proposals. This group includes water experts from the universities and state government. They evaluate and rank research proposals submitted for funding to the institute.

A second problem is the duplication of effort resulting when funds are spent to collect data that may already have been collected by someone else. The cause of this problem is the lack of a central data organization and management facility that can be conveniently accessed to give information on all data available in a specific region or on a specific problem. The first step in any problem-solving effort is to review the information already available. The creation of the Ground Water Information Center would be a major step in the resolution of this problem.

A third concern is that the state may not be taking maximum advantage of on-going ground water investigations in building the data base necessary to assist the agencies in decision-making. One proposal for supplementing this data base is to require parties who conduct state-funded studies to provide a standard set of ground water data to the Ground Water Information Center. The major cost in most ground water investigations is mobilization and drilling; collection of some types of additional data--on ground water quality or temperature, for example--could be gathered with little additional effort and at little additional cost. Although this concept appears sound, there could be problems. One is deciding which data can and should be collected without placing undue burdens on the investigators. For example, requiring that pump tests be conducted on all wells drilled involves a much greater investment of time and money than does measuring water temperature. Second, provisions to assure that data received are usable are imperative. Thus, while the general concept of requiring a standard data set for all investigations is good, further work needs to be done to resolve these and other questions.

Council Recommendations

The Council recommends that EQC work with Montana State University's Water Resources Research Center Advisory Council to encourage interagency cooperation in research and data-gathering efforts. The Council also recommends that all parties who conduct state-funded ground water studies provide a standard set of ground water data to the Ground Water Information Center based in the Montana Bureau of Mines and Geology in Butte. The Montana Bureau of Mines and Geology should determine the composition of this data set.

The Council reiterates its support for a Ground Water Information Center as a means of reducing duplication in data-gathering efforts.

Why the Council Adopted the Recommendations

Interagency coordination is needed to help determine over-all state data acquisition needs, assist in bringing together state agencies with similar data needs, and identify what standard data sets should be collected during ground water field investigations.

The Ground Water Information Center would be needed to provide a means of accessing ground water data already collected so that new studies can be focused on filling existing data gaps and avoiding duplication.

What's Needed to Follow the Recommendations

No action is necessary.

CONCLUSION

The importance of the issues identified in this report becomes clear when one considers the fact that over half of the state's population relies heavily on ground water for domestic and agricultural supplies. This ground water reliance is intensified because, in many areas, ground water is the only source of potable water.

One option available is to take no action. During times of fiscal austerity this is bound to be popular until the long-term costs of inaction become apparent. Other states, particularly in the eastern and southern United States, have effectively eliminated ground water as a water supply option in a number of important aquifers by taking no action to protect their ground water supplies from contamination. Contamination is not easily contained or removed even with elaborate and expensive aquifer restoration techniques. Aquifer restoration is rarely, if ever, effective in cleansing an aquifer to pre-contamination quality. Thus, aquifer contamination is a problem that will plague the state not for months or years, but for generations.

Similarly, lack of action in determining aquifer characteristics, recharge rates and sustainable long-term yields from aquifers will reduce the state's ability to manage the use of ground water so that aquifer depletion is avoided. Long-term consequences of aquifer over-use include financial hardships when speculative investments in irrigation equipment fail to produce, rising energy costs with increased pumping lifts, or, in some cases, complete depletion of a supply.

In comparison, other states, such as North Dakota and Kansas, actively invest in ground water resource investigations state-wide to promote the future use of ground water. Many water districts in southern California pursue the conjunctive use of ground water and surface water by storing excess surface water in ground water aquifers. Montana can lay the groundwork for similar courses of action to effectively manage its water resource.

Montana's ground water resource truly rests in the hands of those in the state who are concerned about our present and future use of this resource. The federal government's policy on ground water leaves a clear message: the states will be responsible for protecting their own ground water. If Montanans fail to manage and protect the resource, the federal government will not do it for us. The resolution of issues depends on how much we value our ground water resource and how far we are willing to go to ensure that ground water is available and usable as the need to develop water resources increases in the future.

With the implementation of recommendations in this report, Montana will have taken a significant step forward in the

protection and management of her ground water resources. Much remains to be done, however. Important issues that remain unresolved include the creation of a stable funding source to finance systematic data collection and organization as well as the development of more effective enforcement of ground water management and protection regulations. These issues should be addressed in the near future.

GLOSSARY OF TERMS

Hydrology, like other branches of science, has its own terminology, and an understanding of certain terms is essential. The definitions here have been simplified and shortened as much as possible.

Acre-foot--A unit for measuring the volume of water. It equals the quantity of water required to cover 1 acre to a depth of 1 foot. It is equal to 43,560 cubic feet or 325,851 gallons.

Alluvium--A general term for clay particles, sand, gravel, or larger rocks deposited by running water. Usually a good, porous, storage medium for ground water.

Aquifer--A geologic formation, group of formations or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs.

Aquifer, confined (or artesian)--An aquifer in which ground water is confined under pressure greater than atmosphere by overlying, relatively impermeable strata. The water level in a well tapping a confined aquifer will rise above the top of the aquifer because of this hydrostatic pressure.

Aquifer, unconfined--Also known as a water table aquifer. The water pressure within the aquifer is at atmospheric pressure. The water level in a well tapping an unconfined aquifer will not rise above the top of the saturated zone in the aquifer.

Base flow--Precipitation delivered to a stream via a subsurface flow route through saturated materials.

Capillary force--A form of water surface tension, causing water to move through tiny pores in rock or soil due to molecular attraction between the water and earth materials.

Capillary water--Water held in tiny openings in rock or soil by capillary force.

Cone of depression--The depression in the water table (unconfined aquifer) or pressure surface (confined aquifer) around a well caused by the withdrawal of ground water from the well. Also known as the cone of influence of the well.

Drawdown (in a well)--The vertical drop of the water level in a well caused by pumping. The magnitude is generally expressed as the difference in feet between the water level elevation in the well just prior to pumping and the water level in the well at a given time during pumping.

Dissolved solids--The total dissolved minerals in water expressed as the weight of minerals per unit volume of water, without regard to type of minerals.

Evapotranspiration--The process of water lost to the atmosphere by evaporation from lakes, streams, and soil surfaces and by transpiration from plants.

Ground water--Water below the ground surface in the zone of saturation.

Head--the elevation of the water level in a well above a horizontal point such as mean sea level.

Hydraulic conductivity--in general terms the ability of earth material to transmit water. It is composed of two parts--the physical size and interconnectedness of pores and the physical properties of the fluid in the pores. The geometry of the pores and degree of interconnectedness are fixed for a particular earth material; however, the hydraulic conductivity of the same material will vary if viscous oil, water or gasoline are flowing through the pores.

Hydraulic gradient--The change in head per unit distance from one point to another in an aquifer. It is a major factor in determining ground water flow rates and directions.

Permeability--synonymous with hydraulic conductivity.

Porosity--The void space in a rock formation, expressed as the volume of pores or voids divided by the total volume of earth material.

Potentiometric surface--An imaginary surface that represents the static head of ground water in an aquifer and is defined by the level to which the water will rise in a tightly cased well. Also known as a "piezometric surface."

Precipitation--Water in the form of hail, mist, rain, sleet, or snow that falls to the earth's surface.

Recharge (to an aquifer)--The replenishment of water to the zone of saturation in an aquifer.

Recovery of pumped well--Refers to the water level rise in a well after pumping is reduced or ceases. The amount of recovery depends on the time period and rate of pumping, the rate of aquifer recharge, the aquifer's porosity and permeability, and other factors.

Static water level--The water level in a well that is not affected by withdrawal of ground water.

Unconsolidated deposits--Primarily clays, silts, sands and gravels that are loosely arranged and not cemented together.

Water table--That surface in an unconfined water body at which pressure is atmospheric; generally the top of the saturated zone.

Zone of saturation--Zones in a rock or soil in which all pores are filled with water.

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